Expansion and Upgrade of the RadNet Air Monitoring Network

Volume 1 of 2

Concept and Plan

Prepared for the

Radiation Advisory Committee
RadNet Review Panel
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DISCLAIMER

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List of Abbreviations

CAM – Continuous Air Monitor
CDX – Central Data Exchange
CEDE - Committed Effective Dose Equivalent
CFR – Code of Federal Regulations
CPIC – Capital Planning & Investment Control
CRCPD – Conference of Radiation Control Program Directors
CTBT – Comprehensive Test Ban Treaty
CZT – Cadmium Zinc Telluride
DEM – Digital Electronic Module
DHS – Department of Homeland Security
DHHS – Department of Health and Human Services
DOE – Department of Energy
DQO – Data Quality Objective
EIC – Electric Ionization Chamber
EMT – Emergency Medical Technician
EPA – Environmental Protection Agency
ERAMS – Environmental Radiation Ambient Monitoring System
ERD – Environmental Radiation Data
FEMA – Federal Emergency Management Agency
FIPS – Federal Information Processing Standards
FISMA – Federal Information Security Management Act
FRERP – Federal Radiological Emergency Response Plan
FRMAC – Federal Radiological Monitoring & Assessment Center
FTP – File Transfer Protocol
GPS – Global Positioning System
IMAAC – Interagency Modeling & Atmospheric Assessment Center
IRM – Information Resource Management
ISO – Information Systems Officer
IT – Integrated Technology
LAN – Local Area Network
LDP – Location Data Policy
LIMS – Laboratory Information Management System
LOPS – LAN Operating Procedures & Standards
LPM – Liters Per Minute
MASB – Monitoring & Analytical Services Branch
NARAC – National Atmospheric Release Advisory Center
NAREL – National Air and Radiation Environmental Laboratory
NCP - National Contingency Plan
NCRP - National Council on Radiation Protection & Measurements
NELAC – National Environmental Laboratory Accreditation Conference
NEWNET – Neighborhood Environmental Watch Network
NICT – National Incident Coordination Team
NIST – National Institute of Standards & Technology
NRC – Nuclear Regulatory Commission
NRP – National Response Plan
NTSD – National Technology Services Division
OAQPS – Office of Air Quality Planning & Standards
OAR – Office of Air & Radiation
OEI – Office of Environmental Information
OMB – Office of Management & Budget
ORIA – Office of Radiation & Indoor Air
OSCs – On-Scene Coordinators
OSWER – Office of Solid Waste & Emergency Response
PAGs – Protective Action Guidelines
PDA – Personal Digital Assistant
PIC – Pressurized Ionization Chamber
QA – Quality Assurance
QAM – Quality Assurance Manual

QAPP – Quality Assurance Project Plan
QC – Quality Control
QS – Quality System
R&D – Research & Development
R&IE - Radiation & Indoor Environments National Laboratory
RAC – Radiation Advisory Committee
RADNET – Radiation Monitoring Network
RERT – Radiological Emergency Response Team
ROI – Regions of Interest
RSC – Response Support Corps
RTG – Radioisotope Thermal Generator
SAB – Science Advisory Board
SASP – Surface Air Sampling Program
SCF – Standard Cubic Feet
SCFM – Standard Cubic Feet Per Minute
SOP's – Standard Operating Procedures
SRNL – Savannah River National Laboratory
STP - Standard Temperature & Pressure
TLD – Thermo Luminescent Dosimeter
TMI – Three Mile Island
USGS – United States Geological Survey
UTC - Coordinated Universal Time
WIC – Washington Information Center

1 INTRODUCTION

1.1 Goal of the New RadNet Air Monitoring Network

This document presents a plan for upgrading and expanding the air monitoring component of RadNet, which is the U.S. Environmental Protection Agency's national environmental radiation monitoring system. Although RadNet since its inception in 1973 has continuously monitored multiple media, including air, precipitation, surface water, drinking water, and milk, the plan in this document addresses only the air monitoring component of the system. After the catastrophic events of 9/11 and the subsequent national concern with homeland security, EPA decided that upgrading the air monitoring portion of RadNet would provide the most useful early data in response to nuclear or radiological terrorist acts.

The plan answers the overarching question of "What changes should be made to the RadNet air monitoring component to best meet the current needs for national radiation monitoring?" Instead of targeting just nuclear or radiological accidents, the mission envisioned in this plan for RadNet now includes homeland security concerns and the special problems posed by possible intentional releases of radiation to the nation's environment. The plan proposes new monitoring equipment, more monitoring stations, more flexible responses to radiological and nuclear emergencies, significantly reduced response time, and much improved processing and communication of data. The ultimate goal of RadNet air monitoring is to provide timely, scientifically sound data and information to decision makers and the public.

Although the events of September 11, 2001 strongly influenced and expedited planning for RadNet and made much needed resources available, the plan presented in this document actually began in the 1990's when EPA initiated the first self-assessments of RadNet. The following sections trace significant events and the planning and decision making process regarding RadNet (then called the Environmental Radiation Ambient Monitoring System [ERAMS]) up to the present time. The lessons learned over time and all previous planning have helped inform EPA's current concept of need and proposed solutions for environmental radiation monitoring.

1.2 National Context for RadNet

1.2.1 Scope of the Existing System

Currently, RadNet is the nation's only comprehensive radiation monitoring network, with more than 200 sampling stations located throughout the United States. The network is multi-media and provides broad geographical coverage as well as coverage of many major population centers. Table 1.1 provides a snapshot of RadNet as a whole—all monitoring networks. Appendix A provides a list of all RadNet stations by city, and Appendix B traces the history of Radnet by change in mission over time.

Table 1.1 Multi-media snapshot of the current RadNet system

MEDIUM	SAMPLING FREQUENCY	NUMBER OF LOCATIONS	ANALYSES PERFORMED
air particulates	2 per week	59	Gross β; If Gross β is >1 pCi/m^3 (0.037Bq/m^3), then γ scan
precipitation	as occurs	41	Monthly composites for γ, H-3 and Gross β
drinking water	quarterly	75	Quarterly H-3, Annual composites for Gross α and β, Sr-90 and γ, If Gross α > 2 pCi/L (0.074Bq/L) then Ra-226, If Ra-226 between 3-5 pCi/L then Ra-228, I-131 on one quarterly sample per year for each station, Annual composite for Pu-238, combined Pu-239 and 240 and U-234, 235 and 238 for stations with gross α > 2 pCi/L (0.074 Bq/L)
milk	quarterly	42	γ on individual samples, Sr-90 on one July sample per region per year

1.2.2 Other Radiation Monitoring Systems in the United States

The Department of Homeland Security's (DHS) Environmental Measurements Laboratory operates the Surface Air Sampling Program (SASP). This global air particulate monitoring network is comprised of approximately 41 active sampling stations worldwide. In addition, DHS operates a global precipitation monitoring network with 45 U.S. sampling locations.

The Department of Energy (DOE) Los Alamos National Laboratory, in cooperation with EPA, operates the Neighborhood Environmental Watch Network (NEWNET). This network measures gamma radiation exposure rate, humidity, barometric pressure, wind speed, and wind direction using real-time monitoring devices with satellite uplink at locations in Alaska and New Mexico. The majority of the sampling sites are located in New Mexico in support of efforts at Los Alamos National Laboratory.

In the United States, DOE has research and development responsibility for monitoring and verification of the Comprehensive Test Ban Treaty (CTBT). In support of the CTBT, which was signed by President Clinton in September 1996, an International Monitoring System and National Data Center has been developed. The monitoring system consists of a worldwide network of seismic, hydro-acoustic, infrasonic, and radionuclide monitoring stations that provide near-real-time data to the National Data Center. There are 80 radionuclide monitoring stations worldwide. Eleven radionuclide monitoring stations are operated by the United States.

Some states also perform environmental radiation monitoring. For example, the Illinois Emergency Management Agency's Division of Nuclear Safety operates a system comprised of gamma dose rate monitoring devices and air particulate sampling at approximately 60 sites. The program, however, is basically directed at in-state nuclear power plants. Similarly, other radiation monitoring systems in the country focus on facility and site monitoring and special studies monitoring (ICF05a). With the exception of RadNet, a comprehensive national environmental ambient radiation monitoring network that focuses on major population centers and broad geographical areas does not exist. (For a more expansive listing of other radiation monitoring systems in the United States see Appendix C.)

1.3 Planning Prior to 9/11

1.3.1 ORIA Assessment of RadNet in Mid-1990's

The first formal planning for RadNet began in the mid-1990's when the Office of Radiation and Indoor Air (ORIA) initiated a comprehensive assessment of RadNet to determine if the system was meeting its objectives and if the objectives were still pertinent to EPA's mission. The impetus for assessing RadNet grew from ORIA's general awareness and increasing concern that RadNet by the 1990's had outlasted its original objectives, which derived from RadNet's precursor systems that had been operated by the Public Health Service in the 1950's and 1960's to monitor fallout from above-ground weapons testing. (Presidential Reorganization Plan No. 3 in 1970 transferred those radiation monitoring responsibilities to EPA along with the associated monitoring systems, which, in 1973, were consolidated and collectively named the Environmental Radiation Ambient Monitoring System (ERAMS) and, in 2005, renamed RadNet.) In addition to looking at major objectives, the goal of the ORIA assessment was to identify any unaddressed concerns and initiatives, potential areas for partnerships and streamlining, and ways in which national non-site directed environmental radiation monitoring could be updated.

1.3.2 SAB Advisories on RadNet in 1995 and 1997

The first Radiation Advisory Committee (RAC) advisory, in 1995, concentrated on an ORIA proposed preliminary design for a RadNet reconfiguration plan and development of objectives for the system. (See Appendix D for details of this advisory.) The second advisory, in 1997, examined the reconfiguration plan for RadNet that was developed, in large part, based upon the guidance received in the 1995 advisory. The reconfiguration plan proposed a three-phased approach for implementation based on zero, some, and optimal additional resources. Upon receipt of the recommendations from the second RAC advisory (see Appendix E) as well as comments from EPA regional personnel and state radiation personnel, ORIA began implementing the reconfiguration plan as resources permitted.

Following the second advisory, the primary improvement to the air network was to upgrade some of the air monitors in the field. Because the existing air monitors had been fabricated at the National Air and Radiation Environmental Laboratory (NAREL) years earlier and were aging and technologically out of date, a number of commercially available air samplers were purchased to replace them. The commercial air samplers can measure flow rate more accurately and have other features that improve field quality control.

1.3.3 Lessons from the Tokaimura event and the DOE Fires

In 1999 and 2000 three events took place that placed the RadNet national air monitoring component on emergency status and, in the process, produced or confirmed some lessons on deficiencies or limitations in the system. First, there was the Tokaimura, Japan, criticality incident in 1999, which, because it was believed to have released noble gases, underscored the fact that the RadNet air system was not designed to detect noble gases. The other two events were uncontrolled fires in 2000: one near DOE's Los Alamos National Laboratory and the other near DOE's Hanford Reservation. The fires underscored two limitations: the low sampling density (few samplers) in both instances and the relatively slow system response time. Because air filters had to be shipped to NAREL for analyses, it took several days for definitive data to reach decision makers and the public. Overall, the message from the fires was that data needed to be more timely and monitoring coverage needed to be more flexible and dynamic—that is, the system needed an effective and rapid means to put monitors in coverage gaps.

1.3.4 New Vision of A Comprehensive National Radiation Monitoring System

In 2001, early in the year and well before the events of September 11, ORIA began generating, through a series of planning activities that included both management and technical staff, a new vision for national radiation monitoring. Implicit in this planning was the goal of utilizing the results from all the work that had gone into the two advisories from the RAC and from the lessons learned in the Tokaimura incident and the DOE facility fires. The result of the 2001 ORIA planning was the first full vision of a comprehensive, multi-component system to address radiological emergency response, which includes national monitoring.

In February of 2001, a key national monitoring system meeting was held in Montgomery, Alabama, the purpose of which was to redefine the mission and objectives of the network and to develop an initial conceptual design to guide the reconfiguration of the network into the future. A significant outcome of the meeting was the determination and agreement that support of the Agency's emergency response responsibilities was to be the primary purpose of the network's current and future radiation monitoring capability. The working mission of the system to be designed, it was agreed, would be: *To monitor radionuclides released into the environment during significant or major radiological emergencies.* Three basic objectives which would support the system's mission also were defined:

- To the extent practicable, maintain readiness to respond to emergencies by collecting information on ambient levels capable of revealing trends.
- Ensure that data generated are timely and are compatible with other sources.

- During events, provide credible information to public officials (and the public) that evaluates the immediate threat and the potential for long-term effects.

The ORIA RadNet planning team not only recognized the linkage between emergency response and the monitoring network but considered the relationship of the monitoring network to other related emergency response assets. Section 2.4 presents ORIA's view of the relationship between RadNet and the other existing EPA emergency response assets.

In August of 2001, the ORIA planning team provided a vision of the new monitoring system that was developed on the basis of four design goals:

- Better Response to Radiological Emergencies
- More Flexible Monitoring Capability
- More Integrated and Dynamic Network
- Meet Needs within Realistic Costs

These design goals would be incorporated into the planning that would soon be triggered by the events of September 11, 2001.

1.4 Impact of 9/11 on Planning the RadNet Air Network

The terrorist attacks on the United States on September 11, 2001 expedited and strongly influenced the subsequent planning for updating and expanding RadNet. In January 2002 ORIA began a self-assessment of the existing monitoring program in light of homeland security concerns, and very early on decided that the air program could best support homeland security objectives. As a result, the review of the other sampling networks in RadNet was deferred to a later time, and the air network received full scrutiny in the system assessment.

The ORIA self-assessment of the RadNet air network identified two major system weaknesses and three proposals to solve them, as shown in Table 1.2.

Table 1.2 Post-9/11 weaknesses discovered in and solutions proposed for the RadNet air monitoring network

Weakness	Proposed Solution
• Decision makers need data more quickly than is currently possible.	• Add real-time monitoring capabilities.
• Assessing widespread impacts from an incident that might occur anywhere in the United States will require data from more locations than are currently monitored.	• Significantly expand the number of locations with fixed monitors. • Provide the flexibility to augment the fixed locations with “deployable” monitors that can be either pre-deployed to a location where there is an increased threat potential (such as a national political convention, Olympics), or quickly deployed after an incident to provide higher monitoring density.

Since planning prior to 9/11 had already endorsed the value and appropriateness of deployable monitors in a new RadNet air monitoring design and because the deployables could be implemented more quickly, the first available homeland security funding (late 2001) was committed to acquiring them. The attention then turned to updating the fixed system. Based on the findings of the post-9/11 assessment and reinforced by similar findings in the earlier 2001 assessment, ORIA turned its attention to the system of fixed monitors to determine the most appropriate equipment; to find the most acceptable plan for siting the monitors across the nation; and to design an electronic capability for delivering verified data (from fixed as well as deployable monitors) quickly to decision makers and the public. In 2002 prototype testing of fixed monitors began, which lasted for over a year and resulted in the conviction that commercially available components could be assembled to meet the performance specifications needed for the RadNet air monitoring program. (See Appendix F for a discussion of prototypes and associated field testing.)

In 2003 EPA decided that the prototyping project had adequately demonstrated the technical feasibility of adding real time gamma and beta monitoring capability to the fixed air monitoring stations. Consequently, in August of 2003 an Exhibit 300 Capital Planning and Investment Control (CPIC) proposal for upgrading and expanding the fixed air monitoring stations component of Radnet was submitted to OMB as part of the Fiscal Year 2004 EPA budget request. The Exhibit 300 document amounts to a business plan that is measured along a number of budgetary concerns, including scope of work, milestone schedule, budget, and risk assessment. In the fall of 2003, OMB evaluated EPA’s proposal, including reviewing it for redundancy against the entirety of the Federal government’s related assets, and gave the plan high marks. As a result, it was included in the President’s FY04 budget request, and subsequently was funded by Congress. In 2004, ORIA was therefore able to begin implementation and acquisition planning, followed in 2005 with actual purchase of an initial order of upgraded fixed station radiation monitors.

The specific objectives and data uses that have guided the development of the RadNet air monitoring network are shown in Table 1.3. The objectives encompass the fixed monitoring network augmented by deployable (mobile) monitors operating in either routine or emergency mode. The objectives and data uses are presented in sequential phases reflecting the chronological progress of an event and the parallel status of the system from routine, to emergency, and back to routine. (Section 2.1 provides a more detailed discussion of the system's mission and objectives.)

Table 1.3 Overview of objectives and data uses for the RadNet air monitoring network

	ONGOING OPERATIONS/PRE-INCIDENT	**EARLY PHASE (0-4 days)**	**INTERMEDIATE PHASE (up to 1 year)**	**LATE PHASE (after 1 year)**
Fixed Monitors				
Objectives	▪ Provide baseline data ▪ Maintain system readiness	▪ Provide data to modelers ▪ Develop national impact picture ▪ Provide data to decision makers and the public	▪ Continue national impact assessment ▪ Reestablish baseline ▪ Provide data to decision makers and the public	▪ Determine long-term impact ▪ Monitor baseline trends ▪ Provide data to decision makers and the public
Data Uses	▪ Pre and post event comparisons ▪ Provide public information	▪ Adjust model parameters and verify outputs ▪ Assist decision makers in allocation of response assets ▪ Identify non-impacted areas ▪ Help determine follow-up monitoring needs ▪ Verify or assist in modifying protection action recommendations	▪ Assist in determining if delayed contamination transport is occurring ▪ Assure citizens and decision makers in unaffected areas ▪ Assist in dose reconstruction ▪ Determine short- or long-term baseline changes from event	▪ Assist in determining if delayed contamination transport is occurring ▪ Assure public that conditions are back to normal ▪ Ensure that recovery efforts are not causing contamination spread ▪ Verify return to previous baselines
Deployable Monitors				(Options: May be Returned to Laboratories or Remain in Field)
Objectives	▪ Provide baseline data (if deployed) ▪ Ensure readiness by conducting regular exercises	▪ Provide data to modelers ▪ Provide data to decision makers and the public	▪ Assess regional impact ▪ Provide data to decision makers and the public	▪ Provide continuity of data in impacted or non-impacted areas ▪ Provide data to decision makers and the public
Data Uses	▪ Pre- and post- event comparisons ▪ Provide public information	▪ Adjust model parameters and verify outputs ▪ Assist in identifying un-impacted areas ▪ Help determine follow-up monitoring needs ▪ Verify or assist in modifying protection action recommendations	▪ Assist in determining if delayed contamination transport is occurring ▪ Assure citizens and decision makers in unaffected areas ▪ Help determine when to relax or reduce protective actions	▪ Assist in determining if delayed contamination transport is occurring ▪ Ensure that recovery efforts are not causing contamination spread

Note.—Objectives and data uses may overlap from one phase to another.

1.5 Summary of Proposed Improvements to RadNet Air Network

The following table provides a snapshot of the proposed improvements to the RadNet air monitoring network presented in this document.

Table 1.4 Main improvements proposed for RadNet air monitoring network

Improvement Area	New System	Old System
Number of Stations	180 (approximately) fixed; 40 deployable	59 fixed; 0 deployable
Time for Data Availability	Near-real-time (4-6 hrs)	36 hours minimum (if on alert)
Criteria for National Siting	Population and Geography	Population and Fixed Nuclear Facility Proximity
Local Siting Criteria	Derived from Title 40 Code of Federal Regulations (CFR) Part 58	None
Data Dissemination	Central Database with Internet Access	Hard copy
Meteorological Data	Yes—deployables Optional—fixed monitors	No
Telemetry	Phone (land line); cell phone; internet; satellite link	None
Station mobility	40 deployable monitors (in addition to 180 fixed stations)	None
Data Security	High	None
Operator Dependency	Primarily for air filter changes; no operator action required for near-real-time data transmission to central database to support emergency response	Completely operator dependent
Gross alpha/beta data at station location	Gross alpha and beta	Gross beta only
U.S. Population Proximity (see Section 3.6)	Approximately 60%	Approximately 24%
Frequency of Data Collection	Continuous (hourly data transmission during routine conditions) and two air filters per week for fixed lab analysis	Two air filters per week for fixed lab analysis

1.6 Strategy and Process for Developing This Plan

ORIA’s strategy for developing the current plan to upgrade and expand the air network of RadNet was based on the following strategic guidelines:

- Emergency response as the overarching, designated mission
- Full exposure to and input from stakeholders to assure that EPA will be doing what is needed
- Inclusion of all of EPA’s national radiation monitoring responsibilities, with special emphasis upon homeland security needs

- High levels of technical and professional expertise incorporated at all levels of planning
- Continuing self-assessment and incorporation of results
- Team structure that incorporates input from all appropriate levels of technical input up to top levels of management, with frequent and regularly scheduled communications
- Utilization of all appropriate previous planning
- Survey, research, and incorporate up-to-date relevant information across the technical, professional, and government communities
- Operation within limits of known and anticipated available resources

The inclusion of stakeholders throughout the planning process has been a high priority. The EPA regions (see http://www.epa.gov/epahome/locate2.htm) have not only been kept well informed, but their direct involvement has been important, particularly in helping to identify site locations and provide for the operation and maintenance of monitors. Similarly, the contributions of the Conference of Radiation Control Program Directors (CRCPD—see http://www.crcpd.org/Map/map.asp) have provided state input and assistance via needs surveys and regular dialogue with ORIA (through a specifically established CRCPD committee to address RadNet issues) on system goals and objectives, scenario assessments, location of monitors, identification of station operators, and so forth. The existing RadNet station operators have also provided very useful information and commentary.

The RadNet team has also aggressively sought information and guidance from sources inside and outside the Agency on issues that could benefit from special expertise. EPA's Office of Air Quality Planning and Standards (OAQPS) was consulted through discussion and documentation on broad issues regarding environmental monitoring that could benefit the design and implementation of RadNet, e.g., best models for developing local siting criteria for the fixed monitors. Since the RadNet air program includes a central database receiving real-time data and eventually providing public information, the Office of Environmental Information (OEI) has provided essential guidance on developing and incorporating the RadNet information technology assets into EPA's overall IT architecture. A specially constructed ORIA Technical Evaluation Panel has also offered commentary and constructive advice on key issues in the RadNet air project, particularly upon the matter of where to best site the fixed monitors.

External sources of expertise have also been important. For example, the National Atmospheric Release Advisory Center (NARAC) and the Savannah River National Laboratory (SRNL) have made substantive contributions. NARAC provided useful modeling support and ran computer scenarios to help assess the ORIA RadNet siting plan. SRNL provided guidance on siting as well, developed a high-level siting methodology, and performed equipment testing of the RadNet fixed monitor prototype. Conversations with the Nuclear Regulatory Commission and Health Canada enabled other means of coordinating the development of RadNet. Through contract support, ORIA secured expertise on a number of specific technical issues, including practices for quality assurance/control pertaining to near-real-time data; particle size issues in monitoring radiation; surveys of radiation monitoring planned or ongoing by other entities; and local siting criteria (ICF05a, LRR05, ICF05b, and ICF05c).

1.7 Current Implementation Status of the Project

The RadNet project currently is in the early implementation phase. Table 1.5 reflects major milestones accomplished and status of work in progress as of October 2005.

Table 1.5 Milestones accomplished and status of RadNet air monitoring project

Item	Comment
Fixed monitor acquisition	Contract let; prototype received, tested and installed in Montgomery.
National siting of fixed monitors	60 most populated cities—15 locations ready to receive; 20 locations with operator but site improvements needed
Local siting of fixed monitors	Local siting criteria established
Deployable monitor acquisition	40 deployable monitors built and delivered to ORIA laboratories in August 2005 (20 to Montgomery, 20 to Las Vegas)
SOP's for monitor operation	Identified and being developed/drafted
Quality Assurance Project Plans	Developed for both fixed and deployable monitors
Data repository for receiving and storing real-time data	Established at NAREL; OEI approved IT security plan for RadNet system
Status of original RadNet non-real-time monitoring stations	All remain in operation but some will be replaced by new equipment in priority order

1.8 Implementation Focus Points Ahead

Although equipment for the fixed and deployable monitors has been purchased, relationships with potential station operator groups are fairly well established for the first purchase batch, and the information technology infrastructure is in place for handling real-time data, the following implementation areas will require careful attention as the project moves forward:

- National sampling/siting plan
- Logistics for emergency distribution and operation of deployable monitors
- Best protocols for distribution/dissemination of verified RadNet data during emergencies

The effective placement of approximately 180 fixed, near-real-time radiation in air monitors across the United States by Fiscal Year 2012 requires that the working approach for siting address major population areas, geographical coverage, and the concerns of partners (states and regions).

The logistics for rapidly and effectively distributing deployable stations during an emergency can be daunting. Ideally, the stations (as many as 40) should be in place and transmitting data within two days of the beginning of a major nuclear or radiological event. Given the realities of not knowing where an event might occur, delivery by other than EPA personnel, i.e., commercial carrier, is likely to add problems and delays. In addition, securing appropriate operators/set-up and maintenance staff quickly in the two-day window for delivery, is another obvious area of potential difficulty and delay. Answering these questions is and will remain high on the project team's agenda. The exercises that are planned to test the RadNet air network are expected to help address and suggest solutions for the logistics issues.

Finally, protocols and practices for data dissemination during an emergency will require ongoing work. Even though the ultimate control of radiation emergency data will reside with the Department of Homeland Security or the coordinating agency (see the Nuclear Rad Annex to the *Homeland Security National Response Plan* [DHS04]), the ways in which this data will be communicated and the development of protocols to accomplish that are likely to develop and change as exercises and new knowledge is acquired in the future. (See Section 5.5 for ORIA's current vision for data sharing and dissemination in the event of a nuclear/radiological emergency.)

2 THE EXPANDED AND UPGRADED AIR NETWORK

2.1 Mission and Objectives of the RadNet Air Network

The mission of the RadNet Air Network is based upon fulfilling, or providing the data necessary to fulfill, responsibilities assigned to EPA in the National Response Plan, Nuclear/Radiological Incident Annex (DHS04). Specifically, the Annex gives EPA the following responsibilities:

- Provide nationwide environmental monitoring data from the RadNet air network for assessing the national impact of the incident.
- Estimate effects of radioactive releases on human health and the environment.
- Recommend protective actions and other radiation protective measures.

To fulfill these responsibilities, EPA developed the following mission for the RadNet Air network:

- Provide data for radiological emergency response assessments in support of homeland security and other responders to radiological accidents and incidents.
- Inform public officials and the general public of the impacts resulting from major radiological incidents/accidents and on ambient levels of radiation in the environment.
- Provide data on baseline levels of radiation in the environment.

The system was designed to fulfill its mission, but it was recognized early that resource constraints would not allow a “do it all” system. Consequently, the system is designed to do the following:

- Measure large-scale atmospheric releases of radiation impacting large parts of the country and major population centers due to:
  - nuclear weapon detonations
  - radiological dispersion devices resulting in widely impacted areas (e.g., multi-county or larger)
  - large nuclear facility incidents/accidents
  - large foreign radiological incidents/accidents
- Measure ambient levels of radiation in the environment

However, the system is not designed to:

- Measure the impact to the immediate locality (“ground zero”) of a major incident/accident
- Measure releases of radiation resulting in a limited impacted area
- Monitor individual sources (nuclear facilities, storage facilities, etc.)

- Serve as an early warning/first detection system

Since there are unique phases of a radiological incident/accident in terms of response, data speed and accuracy requirements, the objectives of the RadNet Air Network were developed based upon three phases, which correspond to those from EPA's Protective Action Guidelines (EPA82).

Tables 2.1 and 2.2 overview the objectives for the fixed and deployable monitors of the RadNet air network during the early phase (typically the first four days following an incident), the intermediate phase (in the time frame of months to the first year), and the late phase (from the end of the intermediate phase) of an incident. Another category, the "pre-incident" phase, is included to show what the monitoring system will do prior to an event.

Table 2.1 Overview of objectives for the fixed component of the RadNet air network

ONGOING OPERATIONS/PRE-INCIDENT	EARLY PHASE (0-4 days)	INTERMEDIATE PHASE (up to 1 year)	LATE PHASE (after 1 year)
Maintain system readiness			
Provide baseline data		Reestablish baseline	Monitor baseline trends
	Provide data to modelers		
	Develop national impact picture	Continue national impact assessment	Determine long-term national impact
	Provide data to decision makers and the public		

Table 2.2 Overview of objectives for the deployable component of the RadNet air network

PRE-INCIDENT IF PRE-DEPLOYED	EARLY PHASE (0-4 days)	INTERMEDIATE PHASE (up to 1 year)	LATE PHASE IF NOT RETURNED TO READY STATUS (after 1 year)
Provide baseline data			Provide continuity of data
	Provide data to modelers		
	Develop local or regional impact picture	Regional impact assessment	Determine long-term regional impact
	Provide data to decision makers and the public		

2.2 Data Availability

The near-real-time data produced by the fixed and deployable monitors are dissimilar. Fixed monitors are designed to obtain continuous gamma spectrometric and gross beta emissions from particulates collected on an air filter using a high volume air sampler. The filter can also be removed and screened by an operator for gross alpha and beta emissions. Finally, the filter can be shipped to the NAREL for more sensitive analysis and for radionuclide specific analyses that cannot be performed in real time or by an operator in the field.

The deployable monitors have two air samplers, one low volume and one high volume. The low volume sampler collects particulates or iodine speciation using special cartridges, and the high volume sampler collects particulates only. Both filters must be removed and shipped to a fixed or mobile laboratory for analysis, but the filters may also be field screened for gross alpha and beta emissions. The deployable monitors also have a gamma exposure rate monitor that provides continuous gamma radiation level measurements. Both the fixed and deployable monitors can provide air flow data, which allows personnel at the NAREL to ensure that the monitors are operating correctly. Table 2.3 summarizes the data available from each monitor type and the time/actions required before the data are useable.

Table 2.3 Summary of data and availability

MONITOR TYPE	DATA TYPE	AVAILABILITY TIMEFRAME [1]	REQUIRED ACTIONS FOR DATA TO BECOME AVAILABLE
Fixed	Gamma Spectrometry	Hourly	None
	Gross Beta	Hourly	None
	Alpha/Beta Screening	5 Hours	Operator removes and screens filter
	Filter analysis	> 2 Days	Operator removes filter, ships to NAREL, and radioanalysis is performed
Deployable	Gamma Exposure Rate	Hourly to daily as directed [2]	None
	Filter analysis	> 2 Days [2]	Operator removes filter, ships to fixed lab, and radioanalysis is performed

[1] From beginning of collection period. Time is based on when data are available to EPA. Dissemination times may vary.
[2] Shipping and monitor setup times, approximately 24 hours, need to be added to obtain total time from the event to the data availability timeframe.

2.2.1 Data Uses in the Pre-Incident Phase

Data will be used to perform trend analyses and to establish a baseline for comparison of data in the spectrometric regions of interest to determine if abnormalities exist. The fixed system operates continuously to ensure that baselines are up-to-date, that the system is operational and ready to detect contamination, and that operator skills remain current. Baseline data may be used by the public, scientists, decision makers and other customers or stakeholders. Although RadNet is not designed to be an early warning system, there is a small probability, because the monitors in the fixed network operate continuously, that they may detect airborne contamination before notifications occur.

If the deployable monitors are pre-deployed, they will provide baseline data of environmental gamma radiation levels as well as low and high volume air samples for analysis at a fixed or mobile laboratory. If they are not pre-deployed, they will be maintained ready for deployment at the two ORIA laboratories.

2.2.2 Data Uses in the Early Phase of a Radiological Event

In the early phase of an incident, the fixed monitor network is designed to accomplish the following objectives:

- Provide radionuclide data quickly to modelers without operator action (The data may be used to assist in modification of assumptions or input parameters or to assist in validation of model output which will most likely be used for initial protective action recommendations.)
- Provide data to determine national impact of event in cities across the nation which may not monitor for contamination, especially if projections of contamination spread do not indicate large potential impact (The system will provide data covering large cities as well as large areas of the nation.)
- Provide data quickly to decision makers and the public to provide assurance to citizens and decision makers in unaffected areas that the airborne radionuclide concentrations are normal
- Provide data to decision makers to assist in prioritizing follow-up monitoring requirements and response resource allocation
- Assist in identifying non-impacted areas by providing modelers and decision makers with “zeros” for areas where contamination is not present or is present below the detection levels, which are designed to be significantly below protective action guidance levels

The deployable monitors, in the early phase, are designed to achieve the following objectives that augment and complement information produced from the fixed monitoring network:

- Provide gamma radiation and airborne radioactive particulate data to modelers to assist in validation of model output or adjustment of input parameters
- Provide data quickly to decision makers and the public to provide assurance to citizens and decision makers in unaffected areas that the airborne radionuclide concentrations are normal
- Assist decision makers in determining follow-up monitoring requirements and response resource allocation

2.2.3 Data Uses in the Intermediate Phase of a Radiological Event

In the intermediate phase, the fixed monitors will:

- Determine if/when levels return to pre-incident values (The data will also assist in determining if temporary or long-term baseline changes have resulted from an event.)

- Provide data for potential of delayed contamination transport from resuspension, multi-pass global transport from nuclear weapon detonations and/or from a continuous release of contamination, such as a fire
- Provide data to assist in assessing the national impact (i.e., population dose reconstruction)
- Provide assurance to citizens and decision makers in unaffected areas that the airborne radionuclide concentrations are normal
- Provide data to assist decision makers concerning reducing or relaxing protective actions that may have been taken in the early phase

In the intermediate phase, the deployable monitors will provide:

- Data for potential of delayed contamination transport from resuspension, multi-pass global transport from nuclear weapon detonations and/or from a continuous release of contamination, such as a fire
- Assurance to citizens and decision makers in unaffected areas that the airborne radionuclide concentrations are normal
- Data to assist in assessing the regional impact (i.e., population dose reconstruction)
- Data to assist decision makers concerning reducing or relaxing protective actions that may have been taken in the early phase

2.2.4 Data Uses in the Late Phase of a Radiological Event

In the late phase, the fixed monitors will provide:

- Data to verify that radionuclide concentrations have returned to previous baseline
- Monitoring data for potential of delayed contamination transport from natural resuspension or man-made resuspension (i.e., resuspension caused by cleanup operations)
- Assurance to citizens and decision makers in unaffected areas that the airborne radionuclide concentrations are normal

In the late phase, the deployable monitors may be returned to the laboratories or they may continue to monitor in the region of the event. If the deployables are returned to the laboratories, they will be serviced as necessary and made ready for the next response. In this scenario, it is likely that substitute monitoring systems which are more appropriate for the long-term monitoring needs of the late phase will be substituted (i.e., there would be no need for additional gamma exposure rate monitoring or low volume air sampling). This would allow the more specialized deployable monitors to be made ready for another emergency event.

However, if the deployables remain deployed in the region of the event, they will provide the following:

- Monitoring data for delayed contamination transport from natural resuspension or man-made resuspension (i.e., resuspension caused by cleanup operations)
- Assurance to citizens and decision makers in unaffected areas that the airborne radionuclide concentrations are normal

2.3 How the Upgraded Air Network Meets Its Objectives

Upgrading the RadNet air network has three major emphases: Adding near-real-time data transmission capabilities, significantly expanding the number of fixed monitor locations, and adding 40 new deployable monitors to the system. These upgrades address the two weaknesses identified in the post-9/11 reassessment of the system – that decision makers need information more quickly, and that incidents occurring anywhere in the U.S. may not be adequately monitored by the widespread fixed monitors.

Scientists need accurate, complete, and *timely* information concerning radioactive contamination in the environment in order to provide decision makers with the best possible information from which protective action decisions will be made. The RadNet fixed monitors will provide data quickly by continuously monitoring the filter for gamma and beta radiation and by providing a means to transmit the data to a central location for evaluation, assessment, and dissemination.

Many potential protective actions are based initially upon computer model projections of dose, especially when little or no monitoring data exist early in an incident. The fixed system provides a continuously operating monitor that may detect radioactive contamination as it travels through the environment. The data collected can be used to refine source-term activity as well as to define the radionuclide(s) released. This can be a critical issue in surprise events, such as a dirty bomb scenario, where the nuclides and source terms must be guessed until confirmed by measurements.

Also, by placing numerous detectors across the nation, the chances of detecting contamination as it spreads increases and data can be used to validate long-distance transport of contamination. Increasing the number of fixed monitors throughout the country improves the system’s ability to meet its objectives in a very tangible way. New monitors with updated components and better capabilities are being purchased and installed to improve system coverage.

The deployable component of the air network is another upgrade feature that helps RadNet meet its objectives. Primarily, the deployables serve to improve system coverage before an incident (if pre-deployed) and after an incident. Lack of system coverage was a weakness identified during the post 9/11 reevaluation of RadNet. Since it would take an unrealistic number of fixed monitors to provide truly 100% coverage of the U.S. population, the deployable monitors are stored in a state of readiness and can be deployed to monitor radioactivity.

The deployables complement the fixed air monitor network by essentially “filling the gaps” in coverage. Although the fixed and deployable monitors have different components and are designed to be used in slightly different ways, both types of monitors provide the same thing overall: information about radiological material in the environment. Because there is such wide variation in the extent and distribution of radioactive material under the numerous possible incident scenarios, the combination of widespread and constantly operating fixed monitors and the movable, more closely situated deployable monitors provide better coverage flexibility.

2.4 Role of the Air Network in Relation to Other Emergency Response Assets

RadNet is just one part of EPA’s overall emergency response capability and can provide big-picture information—major geographical areas and population centers—in the event of a nuclear emergency. RadNet’s data will be used to supplement data that will be collected by local, state, and federal responders working in the immediate impacted area following a nuclear or radiological emergency.

Under the National Response Plan (NRP) and its Nuclear/Radiological Incident Annex—the national framework for response to radiological incidents—state, tribal, and local governments primarily are responsible for determining and implementing measures to protect life, property, and the environment in impacted areas (DHS04). Toward that end, many, if not most, urban areas have developed local hazardous materials incident response teams that include radiological/nuclear emergency response resources. In addition, state governments maintain radiological emergency response personnel and equipment that will be deployed to the scene of an incident following notification. These resources will be supplemented at the federal level by radiological response resources such as the following:

- DHS’ Interagency Modeling and Atmospheric Assessment Center (IMAAC), which is responsible for production, coordination, and dissemination of consequence predictions for an airborne hazardous material release
- The Federal Radiological Monitoring and Assessment Center (FRMAC), which will be established by DOE at or near the scene of an incident to coordinate radiological assessment and monitoring
- The Advisory Team for Environment, Food, and Health (known as “the Advisory Team”), which provides expert recommendations on protective action guidance

EPA provides support to each of these federal assets during the immediate response to an emergency, and takes over leadership of the FRMAC for the longer-term response. Data from RadNet will be coordinated with all three of these assets to ensure that state and local decision-makers receive the full suite of information available to help them protect the public following a nuclear or radiological emergency.

In support of the overall federal, state, and local response effort, EPA will deploy personnel to work in the immediate impact zone and to investigate the potential impact of the incident in the areas immediately surrounding the impact area. EPA assets include the following:

- A Radiological Emergency Response Team (RERT), a group of trained personnel who perform field measurements, collect samples, and perform limited analyses in mobile laboratories. RERT personnel can also provide other responders with advice and technical assistance on issues ranging from protective measures to containment and cleanup following an incident.
- A cadre of On-Scene Coordinators (OSCs) from EPA's Superfund program, who respond to the scene of biological, chemical, or radiological emergencies under the National Oil and Hazardous Substances Pollution Contingency Plan (the NCP), as well as the NRP's Nuclear/Radiological Incident Annex. EPA's OSCs are trained to conduct, direct, or coordinate emergency response actions to ensure that human health and the environment are protected.
- An EPA Environmental Response Team that supports the On-Scene Coordinators in their response activities, providing specialized equipment and technical issues including hazard evaluation, risk assessment, multimedia sampling and analysis program, and on-site safety
- The EPA National Decontamination Team, a team of emergency responders, engineers, and scientists available to provide technical decontamination advice and assistance at the scene of an incident
- A large EPA fixed-laboratory capability for both radiological and mixed chemical/radiological sample analysis. Samples can be shipped from a site to the laboratories for more thorough analyses and longer counting times to improve detection capability.

These components work together and with the other federal, state, and local responders to provide information concerning radiological contamination of the environment both near and far from an incident site.

In the event of a radiological emergency, the RERT and other EPA assets described above will proceed to the impacted areas to integrate into the on-site response and the FRMAC. EPA's RERT and other Federal, state, and local response assets will primarily respond from the immediate impact area to about 30 miles out (although the distance will depend on the magnitude and area of the contamination spread). RadNet will help to augment these emergency response assets by providing data from the extended area around the site, where more long-term health impacts (indicated by exceedances of the intermediate PAGs and other health standards) may be the concern. The RERT also brings mobile laboratories with the capability to perform rapid gamma spectrometry and alpha/beta analyses on samples collected by the RERT or other monitoring groups.

ORIA's two laboratories, the National Air and Radiation Environmental Laboratory (NAREL) located in Montgomery, AL, and the Radiation and Indoor Environments National Laboratory (R&IE), located in Las Vegas, NV, maintain the ability to process and analyze samples collected in the field. The fixed laboratories also process air filters collected and sent from both the fixed and the deployable monitors. Other entities, such as states or site monitoring programs, may request EPA's laboratories to analyze samples that exceed their own capabilities or capacities. In addition, DOE and other Federal, state, and local agencies will contract with independent commercial laboratories to analyze the significant number of samples that will be generated by a significant radiological or nuclear incident. In such instances, EPA's NAREL will likely serve as either a quality assurance or a reference laboratory to ensure the accuracy of the analyses being obtained. All data will be coordinated through the FRMAC, to develop a single common operating picture, as required by the NRP.

3 FIXED MONITOR NETWORK

As discussed in the introduction to this document, one of the weaknesses identified in the post-9/11 reassessment of the RadNet air network was that decision makers need data more quickly than is currently possible. The solution proposed was to augment the capabilities of the fixed air stations with real time monitoring. The first step in determining functional requirements for real time measurements was establishing measurement objectives, beginning with an assessment of threats posed by potential terrorist activities, decisions that might need to be made to protect human health and the environment, and data that would be needed to make those decisions.

Although the events of 9/11 created a heightened sense of urgency, the potential radiological health and safety issues related to the threat of terrorist activities involving radioactive material had been recognized and studied for 20 or more years. The National Council on Radiation Protection and Measurements (NCRP) completed Report No. 138, *Management of Terrorist Events Involving Radioactive Material* (NCR01), just prior to 9/11. This report was used as a primary source of information in assessing the capability needs for upgrading the RadNet air network. However, in evaluating the likelihood of the various postulated scenarios, the NCRP committee generally discounted those involving lethal radiation exposures to the perpetrators. The events of 9/11 made it clear that some terrorist groups may not be unconcerned about their own safety. For this reason, EPA considered the full range of postulated scenarios rather than discarding those deemed likely to be lethal to the perpetrator.

While it is not possible to predict all of the ways in which data from the RadNet air network might be used in responding to a radiological event, the one that would be limiting for design purposes was identified as recommending protective actions for the public. As stated in NCRP Report 138, available immediate actions for areas downwind from an incident site are temporary shelter in place or evacuation. These recommendations must be based on a projection of the radiation dose that can be averted by taking the action, which in turn requires estimates of the time available before cloud arrival, the duration of exposure, and the concentration in air of each radionuclide in the cloud. It is this last item of data that can be provided by the air network.

It may be unlikely that the data from a RadNet air monitoring station would be used, by itself, to make a recommendation for implementing a protective action. It is anticipated that a more likely use would be to reassure people in population centers that are not expected to be impacted by an event that no protective action is warranted. However, the required sensitivity, quality, and timeliness of data is the same for either of those potential uses. Providing data suitable for making protective action decisions was therefore established as a design objective. EPA believes that meeting this objective will ensure that the data is also suitable for any other potential uses in responding to a radiological event.

After it was determined that the objective was to measure the concentrations of radionuclides in air, the next step was to determine the radionuclides and sensitivities that should be measured. Radionuclides likely to be encountered were identified by considering the categories of events described in NCRP Report 138, which included both radiological dispersal events and detonation of nuclear weapons. For dispersal events, the categories evaluated included both sabotage of a fixed nuclear facility or transport vehicle and fabrication of a weapon using radioactive materials obtained either legally or illegally. EPA supplemented the information in NCRP Report 138 with discussions with others in the radiological community, primarily at the national laboratories, who also were involved in re-assessing terrorist threats.

The conclusion was that gamma spectrometry can measure every available source of radioactive material of sufficient size and sufficiently long radioactive half-life to cause large-scale public health impacts, except for the following sources:

- Pu-239, (and other transuranic alpha emitters) which is available in large quantities and emits only alpha radiation (However, a large quantity of Pu-239 would be required to produce large-scale public health impacts if dispersed. Large quantities of Pu-239, which is heavily guarded and would require considerable resources to obtain, also can be used to fabricate an improvised nuclear device that would have much greater impacts.
- Sr-90, which emits only beta radiation, and is available in large quantities

In addition to the fission mixtures and Sr-90, individual gamma-emitting radionuclides that might need to be measured because they are readily available in large quantities were identified as Am-241, Cs-137, Co-60, and Ir-192. The conclusion reached was that the ability to measure both gamma and beta radiation was needed, but that detection of alpha radiation was not critical and could be best addressed by laboratory analysis of the filters.

EPA periodically revisited this radionuclide list as additional threat assessment information became available, up to the time when bid specifications for the monitoring equipment were finalized in early 2004. The most recent publicly available report consulted at that time was *Individual Preparedness and Response to Chemical, Radiological, Nuclear, and Biological Terrorist Attacks* (DAV03), published by the Rand Corporation in 2003. Appendix A in that report contains a list of radionuclides identical to that derived by EPA in 2002.

An objective for measurement sensitivity was established based on the need to reach a protective action recommendation while time is available to implement a protective action. Therefore, the measurement sensitivity goal was set at the concentration in air that would result in a Committed Effective Dose Equivalent (CEDE) of one rem (the lower guideline value for implementing a protective action) if inhaled continuously for four days. Four days was the period chosen to provide adequate time for confirmation and verification of a measurement, followed by a deliberative decision making process, and the subsequent worst-case (in terms of time required to fully implement) potential protective action, which was assumed to be the controlled evacuation of a large city.

Detailed specifications for the fixed monitors were developed based on experience gained from a project that began in 2002. Four prototype monitors were assembled by integrating commercially available components and software from multiple vendors. The prototypes were installed at four locations in the United States and field-tested for at least one year. The prototyping project, described in more detail in Appendix F, concluded that none of the detectors tested was capable, by itself, of meeting the measurement objectives. However, it was also concluded that it was feasible to implement the conceptual design with currently available technologies and components, if an appropriate combination of detectors were used and properly integrated. Based on this conclusion, and to allow for the broadest possible competition as well as to encourage potential bidders to propose innovative approaches, the specifications prepared for procurement of the monitors were performance based rather than specifying which detector technology to use.

3.1 Major Components

Each of the fixed air monitoring stations will consist of the following components:

- A high-volume air sampler that draws air through a fixed sample collection filter, with instrumentation for measuring sample air volumetric flow rate and total flow
- Instruments for measuring ambient air temperature and barometric pressure
- Instruments for measuring gamma and beta radiation emanating from particles collected on the air filter media
- A real-time clock/timer/controller subsystem
- An operator interface and control subsystem
- A computational unit capable of performing limited calculations and unit conversions on instrument outputs
- A data logger that continuously records and stores data from the instrumentation and air sampler
- A telemetry system with redundant telecommunications capabilities
- An environmental enclosure that houses and distributes electrical power for all of the equipment
- A telescoping mast that attaches externally to the environmental enclosure, with provisions for mounting telecommunications antennas and optional wind speed and direction instruments
- Optional instrumentation for measuring wind velocity and direction. All stations will have the capability to be equipped with these instruments, but they will only be installed at locations where the data would be meaningful (e.g., no “urban canyon” or building wake effects, no local interferences, etc.)

All of these components will be fully integrated to complement and inter-operate with the other components, without unnecessary redundancy.

3.2 Air Sampler

The air sampler will consist of a sample air inlet, filter holder assembly, air pump and flow rate control system, and flow rate measurement device. It will use a 4 inch (10 cm) diameter round polyester fiber filter, positioned between 3.28 and 3.77 feet (1.0 and 1.15 m) above the floor or other horizontal supporting surface.

The sampler will have a sample air flow rate control system capable of providing an adjustable volumetric flow rate between 1230 and 2650 cubic feet per hour (35 and 75 m^3 per hour). The flow rate will be regulated to within ±5 percent of the programmed rate. It will also have instrumentation to measure volumetric flow rate, corrected to standard temperature and pressure (STP) using on-board ambient air temperature and barometric pressure sensors.

3.3 Radiation Instruments

The monitoring stations will be equipped with instruments for continuously measuring beta and gamma radiation emitted from particulate matter that has collected on the sampler filter. The detectors will be mounted as close as possible to the filter media, but in a manner that does not significantly disrupt air flow or interfere with the routine changing of filter media.

The gamma radiation detector will be a NaI(Tl) scintillation crystal with integral temperature sensor and heating. The heater will maintain a constant temperature above freezing to prevent cracking of the crystal and aid in gain stabilization. A small Am-241 light pulser with a gamma-equivalent energy of 3 MeV will be used for fine gain stabilization, leaving a useful gamma energy range of at least 50 to 2,000 keV. The detector will be coupled to a 1,024-channel multi-channel analyzer and local processing unit. Compensation for static ambient background from soil and cosmic rays will be provided by means of proportional subtraction based on a background spectrum file. Compensation for dynamic background, from varying radon and thoron progeny activity on the filter, will be performed using spectrum stripping based on the net area in non-interfering radon/thoron progeny gamma photopeaks.

Each gamma spectrum will be stored locally in a separate digital file. The minimum information required to be stored in each file includes the spectrum name, number of channels, acquisition start date and time (Coordinated Universal Time, or UTC), acquisition stop date and time (UTC), real time in seconds, live time in seconds, coefficients for the energy calibration equation, a minimum 64-character field for information or comments entered by the operator, and integer values corresponding to the accumulated counts in each memory channel.

In the presence of background Pb-214 and Bi-214 particles on the filter media at levels varying from 300-30,000 pCi (11 Bq to 1100 Bq) and with the radioactive particles uniformly distributed over the active collection area of the filter media, specifications require the following minimum detectable activities at the 95% confidence level with a counting data acquisition time of no greater than one hour:

Radionuclide	MDA at 95% CL	
Am-241	5 nCi	(185 Bq)
Cs-137	3,000 nCi	(111 kBq)
Co-60	810 nCi	(30 kBq)
Cs-134	2,000 nCi	(74 kBq)
Ir-192	1,000 nCi	(37 kBq)
Eu-154	200 nCi	(7.4 kBq)
Eu-152	300 nCi	(11 kBq)

The detector is arranged to optimize efficiency for measuring radiation emitted from particles collected on the filter. Although it was not a design objective, the detector can also qualitatively measure noble gas radionuclides present in the air in which the detector is immersed. (For additional information on particle size, among other special topics related to the fixed monitors, see Appendix M.)

The beta radiation instrument will use a silicon detector with an entrance window thick enough to stop 8 MeV alpha particles, and will be designed to minimize response to gamma radiation. In the presence of background Pb-214 and Bi-214 particles on the filter media at levels varying from 300 – 30,000 pCi (11 Bq to 1100 Bq) and with the radioactive particles uniformly distributed over the active collection area of the filter media, the instrument will have sufficient sensitivity to quantitatively measure 85 nCi (3 kBq) of Sr-90 (in equilibrium with Y-90) at the 95% confidence level with a counting data acquisition time of no greater than one hour.

When measurement sensitivity objectives were first determined at the beginning of the prototyping project early in 2002, they were based on air concentrations derived using the one rem Committed Effective Dose Equivalent guideline from the Environmental Protection Agency's Protective Action Guideline (PAG) Manual (EPA92). By late 2003 when development of bid specifications for procuring monitors began, there were discussions of revising the PAG Manual to replace the dose-based approach with a risk-based approach. In order to ensure that the monitors purchased would continue to meet measurement sensitivity objectives if risk-based PAGs were to be adopted, corresponding air concentrations were re-calculated based on the inhalation risk factors and average breathing rate given in Federal Guidance Report 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides* (EPA99). A sample collection rate of 2120 cubic feet per hour (60 m^3 per hour), a target lifetime mortality risk factor of 2/10,000, and 100 hours of exposure were assumed for these calculations. Values for the detection limits listed above were then selected based on the more conservative value derived using the two different approaches.

The range of radon progeny background concentrations was based on data published in the National Council on Radiation Protection and Measurements (NCRP) Report No. 45, *Natural Background Radiation in the United States* (NCR76). The radionuclides were selected to be representative of the variation in efficiency over the desired gamma energy range of the gamma detectors that might be used in this application, with consideration of their likelihood of being used in a radiological dispersion device. The alpha energy of 8 MeV is based on preventing interference with the beta measurement by radon progeny that emit high energy alphas, of which Po-214 with an alpha energy of 7.7 MeV is limiting.

3.4 Data Processing and Storage

The monitoring stations will have the capability to perform calculations, unit conversions, etc., on raw inputs in order to provide output in the desired formats:

- Absolute barometric pressure and ambient temperature will be used to correct the measured volumetric flow rate to STP. Sample flow rates and integrated total flow for the sample period will be displayed locally, stored in the data logger, and transmitted in units corrected to STP.
- Flow rate measurements will be integrated to determine the total sample flow for each sampling event and for each interval of radiation instrument data acquisition.
- For each gamma radiation spectrum, the counts accumulated in at least ten separate user-definable regions of interest (ROIs) will be integrated, then divided by either the live time or real time (user-definable) to determine the count rate in counts per minute for each ROI.
- For each completed counting interval for the beta radiation instrument, the count rate in counts per minute will be determined.

Data will be stored on the monitor in non-volatile memory with a first-in/first-out basis, so that the most recent records are always available and the oldest records are overwritten if necessary. Data storage capacity will be adequate for at least the most recent 599 radiation instrument data acquisition intervals, and will include the following:

- Date and time (UTC) that acquisition began and ended
- Real time and live time for data acquisition in seconds
- Beta count rate
- Count rate for each gamma ROI
- Total volume of air that has passed through the filter since the last filter change
- Complete gamma spectrum file
- Ambient air temperature and pressure, and wind speed and direction, averaged over the data acquisition interval

In addition, the following data will be stored for the current (if a sample is in progress) and at least the most recent two sample collection intervals:

- Date and time (UTC) that sample collection began (and ended, if applicable)

- Total sample volume (corrected to STP) collected (or collected thus far, if sampling is in progress)
- Average, minimum, and maximum sample flow rate (corrected to STP)
- Total number and duration of any power interruptions lasting more than one minute

3.5 Data Telemetry

The monitoring stations will have a telemetry system with multiple redundant telecommunications capabilities. It will include the necessary hardware, firmware, and software to both send and receive data, using point-to-point protocol, by all of the following methods:

- V.92 hardware modem via analog connection to a local telephone service provider (software modems are unacceptable)
- “Third-generation” cellular telephone data modem
- 10/100 Base-TX Ethernet, IEEE 802.3 compliant
- LandSat satellite transceiver

Antennae for the cellular telephone and satellite transceivers will be mounted on an external mast.

The telemetry system will be capable of automatically transmitting data at user-programmable intervals between 10 minutes and 7 days without operator intervention. It will automatically poll communication resources for availability, and automatically switch to an alternate communications method if the primary method is unavailable. The designation of primary and alternate methods, and their order of preference, will be user-programmable.

Data encryption will be available for all of the telemetry methods, and the telemetry system will be capable of accepting and connecting with incoming transmissions to allow for remote user interface and control.

3.6 Fixed Monitor Siting

This section presents EPA’s national siting plan for the fixed air monitoring network and the basis for its development. Section 3.6.1 presents an overview of the siting plan design, including primary objectives, key constraints and decisions, and alternative design methodology. Section 3.6.2 describes the siting plan that EPA selected, along with a step-by-step description of the method developed for selecting monitor locations nationwide. It also summarizes the results of a limited number of sensitivity analyses designed to test the robustness of the selection method, assuming different input parameters. Section 3.6.3 outlines a proposal for confirmatory testing of the network, as designed, using computer-simulated release scenarios and atmospheric dispersion modeling techniques. Finally, Section 3.6.4 summarizes the siting process.

3.6.1 Siting Plan Design

Decisions regarding where the fixed air monitors are deployed in the RadNet network must be considered carefully and thoughtfully because the monitor locations determine whether or not the system ultimately achieves its intended mission. Given the vast size of the United States, its unevenly distributed demography, and the large uncertainties in the nature, scope, and location of potential radiological incidents, these decisions are inherently complex and involve compromises between competing requirements and finite resources.

Recognizing these complexities and their importance in the siting design, EPA's goal was to design a siting plan that would be logical, transparent, flexible, and defensible. *Logical*, in this context, means that the plan's design should be based on a systematic identification and assessment of the principle siting objectives and important network requirements; *transparent* means that all critical design assumptions, decisions, and steps should be presented and explained clearly; *flexible* means that the siting plan method should be able to incorporate practical considerations of implementation while retaining the network's basis and connection to its objectives; and *defensible* means that, when compared with other possible approaches, EPA's plan should be able to stand on its own merits and be acknowledged as a reasonable solution to a complex problem. The following subsections discuss each of these design elements in sequence. EPA's selected siting methodology is described in Section 3.6.2.

3.6.1.1 Siting Objectives

As a first step in the design process, EPA identified two primary siting objectives:

- Consistency with RadNet's mission and objectives
- Consideration of practicalities

Each of these objectives places different requirements and constraints on the siting plan design.

<u>Consistency with RadNet's Mission and Objectives</u>

The first objective of the monitor siting plan is that it be consistent with RadNet's mission and objectives. As described in Section 2.1, RadNet's mission is to: (1) provide data for radiological emergency response assessments in support of homeland security and radiological accidents; (2) inform public officials and the general public of the impacts resulting from major radiological incidents/accidents and on ambient levels of radiation in the environment; and (3) provide data on baseline levels of radiation in the environment. To fulfill its mission, the system is designed to

- Measure large-scale atmospheric releases of radioactivity impacting large parts of the country and major population centers due to:
  - nuclear weapon detonations
  - radiological dispersion devices resulting in widely impacted areas (e.g., multi-county or larger)
  - nuclear facility incidents/accidents
  - foreign radiological incidents/accidents
- Measure ambient levels of radiation in the environment

Conversely, the system is not designed to monitor the immediate vicinity of incidents/accidents or provide early warning or first detection capability.

From a design perspective, RadNet's mission focuses on the need for a network that is responsive to large-scale radiological incidents on a national level, with emphasis on evaluating the impact of these events on major population centers and large areas of the country.

Table 3.6.1 illustrates how RadNet's objectives also influence siting design. The first column lists selected RadNet objectives, such as providing information to various data users. The second column, Related Attributes, refers to specific information that is of value to or supports the objective. For example, decision makers (see first row) gain important information about the plume's path from stations that report background levels of radioactivity during an incident (i.e., the value of "zeros"). The third column specifies whether the primary focus of the objective is population or area coverage. Population coverage refers to a design that places monitors preferentially in major population centers, whereas area coverage implies a design where monitors are distributed to cover wide areas. The last column relates the impact of each objective on the siting design.

Table 3.6.1 illustrates that two broad categories, population and area coverage, impact siting design, especially as they relate to the needs of the primary data users and uses. For example, atmospheric dispersion modelers are more likely to prefer an area-based

Table 3.6.1 RadNet objectives and their impact on siting

RadNet Objective	Related Attributes	Primary Focus	Impact on Siting
Provide data to decision makers	Value of "zeros"	Population	Coverage of major population centers
Verify and assist the modification of Protection Action Guidelines (PAGs)	Agriculture, cattle, etc.	Population	Coverage of major population centers and coverage of areas related to public health
National dose reconstruction		Population	Coverage of major population centers
Provide data to modelers	Meteorology, scenarios	Area	Monitors widely distributed
Develop national impact picture		Area	Monitors in low population areas and limited number of monitors total implies limited number per city
Monitor known radiological event	Meteorology, scenarios	Area	Monitors widely distributed
Identify areas not impacted	Value of "zeros"	Area	Monitors widely distributed and fewer monitors per city
Help Determine Follow Up Monitoring Needs	Increase probability of detection	Area	Monitors widely distributed

network in order to maximize the probability of a detection given an unpredictable event location. Multiple detections from multiple locations help define the spread of contamination and provide better statistics to reduce uncertainty in model outputs. On the other hand, risk assessors and decision makers are more likely to prefer a system focused on population centers. Since the requirements of different data users may diverge, it is clear that EPA needs to develop a siting methodology that is flexible and incorporates both the population- and area-based requirements.

<u>Consideration of Practicalities</u>

The second siting objective, consideration of practicalities, refers to a host of factors that enter into the monitor site selection process, including infrastructure, operator requirements, and the interests of EPA's partners who will use the monitoring data. These factors are discussed further in Section 3.6.1.3.

3.6.1.2 Key Design Constraints and Decisions

The siting objectives, discussed in the previous section, focus the monitor network design on large-scale radiological incidents with nationwide impacts, specifically within major population centers several tens or hundreds of miles downwind of the event. The objectives also highlight the competing needs of different data users in terms of population versus area coverage.

From these focal points as well as others discussed here, EPA identified and incorporated the following design constraints and decisions into the sitting plan design:

- Limited number of monitors (e.g., 100-200): This design constraint is based on practical considerations, that is, the resources EPA might reasonably expect in the future and the capital needed to purchase and deploy the monitors, as well as to operate and maintain the network. Based on current budget projections, EPA anticipates a network consisting of 180 monitors.

- One monitor per city: This design decision is consistent with the system's objective to cover large-scale radiological incidents nationwide. Compared to a multiple-monitors-per-city approach, the one-monitor-per-city approach allows more cities to be monitored, provides better spatial distribution of monitors across the nation, and monitors numerous localities, thereby building greater national support. Of course, the primary disadvantage of this approach is its inability to completely cover and detect events in any given city.

  On the other hand, the alternative multiple-monitors-per-city approach (similar to the Biowatch network - www.epa.gov/oig/reports/2005/20050323-2005-P-00012.pdf) is more likely to detect a local event and provides better coverage for that city. However, even with extensive monitors surrounding a city, there would still be no guarantee of detection. Cost would severely limit the number of cities that could be monitored. Moreover, this approach results in very limited population and area coverage nationwide.

- Existing monitor locations not considered: This design decision acknowledges the differences in the conceptual designs and missions of the former ERAMS and current RadNet networks. Many of the current monitor locations were selected based primarily on convenience and operator availability. RadNet's revised mission and objectives require better area coverage and monitoring in large population centers, and the redesigned monitors add enhanced capabilities.

- Deployable monitors not considered: Although these systems are complementary, EPA believes that fixed siting decisions should be made independently of the use of deployables given that the deployable monitors may be deployed in several ways including more concentrated monitoring near a particular location as described in Section 4.2.

- Monitors detect releases well downwind of an incident: This design constraint underscores the fact that the network is designed specifically to detect the transportation and dispersion of radioactive particulates tens of miles downwind of an event. Local responders and emergency response personnel are expected to provide monitoring in areas close to the event.

- Monitors are receptor-based not source-based: This design decision refers to EPA's preference that the network be designed to measure receptors (i.e., people) not sources (e.g., nuclear facilities). Other monitoring systems provide smaller-scale monitoring around particular facilities, but the RadNet monitoring system is designed to assist in determining if distant transport from a location is occurring or has occurred.
- Monitor installation will proceed concurrently with siting plan development: This design decision reflects EPA's desire to proceed rapidly with the implementation of the monitoring network and to develop a flexible siting methodology.

3.6.1.3 Alternative Design Approaches

The siting objectives and key design constraints and decisions, established in the previous sections, provided the framework for the next step in the design process—identification and evaluation of alternative approaches for developing a siting methodology. EPA identified three approaches that best fit within the design framework:

1) The population-only based approach focuses on placing monitors where people live. It is consistent with the siting objective to protect human health by assessing potential impacts in major population centers and with the design decision in favor of receptor-based monitor siting. Given its single objective, this approach is also easy to understand and implement, i.e., rank the largest cities in the United States using the latest census data and then place one monitor in each of the top-ranked cities according to the total number of monitors available. Fig. 3.6.1 shows the locations of major U.S. population centers, and Fig. 3.6.2 illustrates how the network might appear if 180 stations are sited using this approach.

   The population-only based approach offers several other advantages over the other approaches. First, the majority of major population centers in the U.S. would be monitored. Second, the distribution of monitors across the U.S. would provide some area coverage and additional data points for the atmospheric modelers. As highlighted by Fig. 3.6.2, the approach's major disadvantages are that it overlooks large land areas and less-densely populated metropolitan regions of the U.S. and results in the "clustering" of monitors (monitors that are too closely spaced and provide little additional useful information on plume characteristics) in heavily populated areas in California, Texas, Florida, and portions of the northeast.

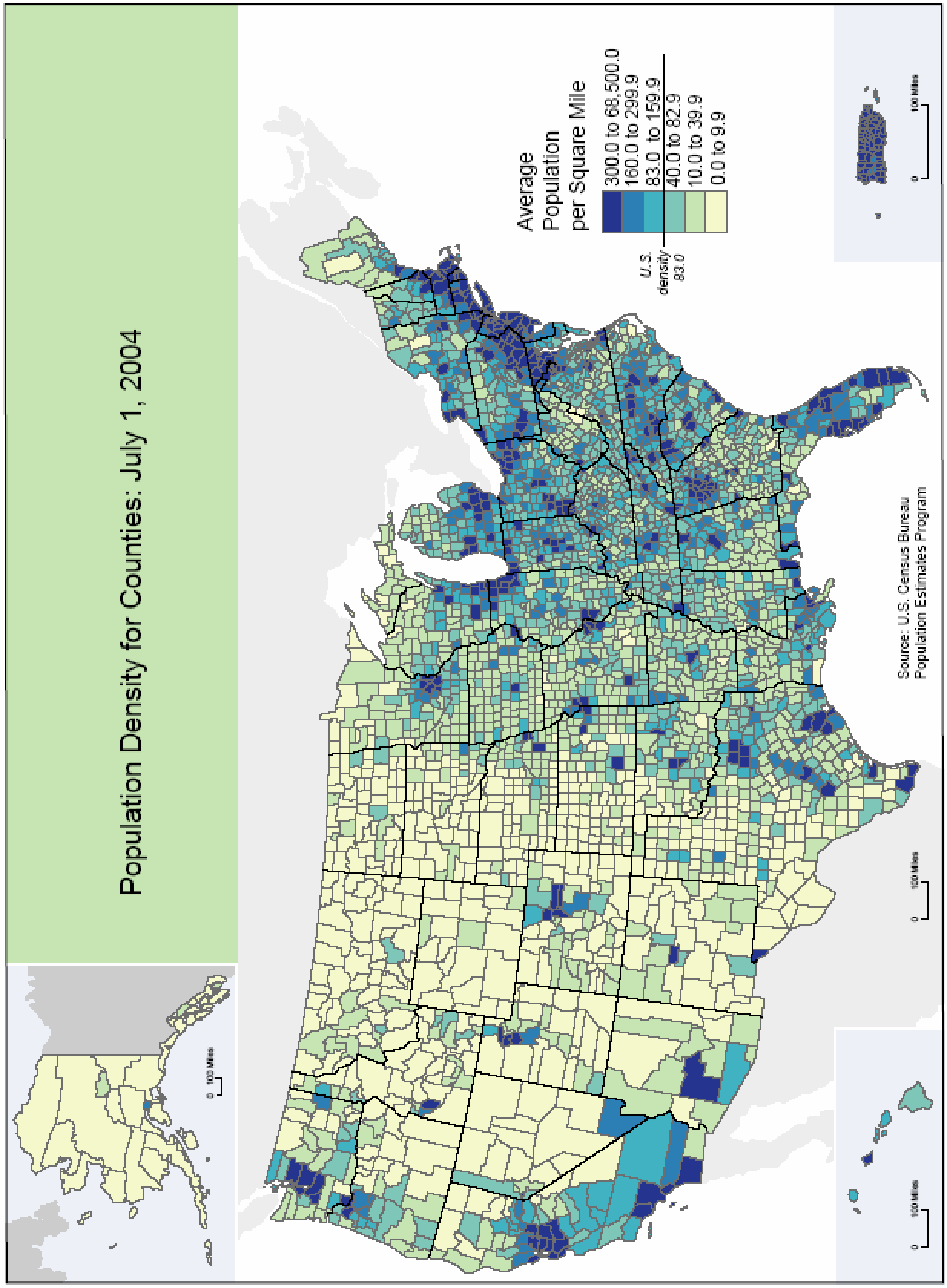


Fig. 3.6.1. U.S. census county population densities, 2004

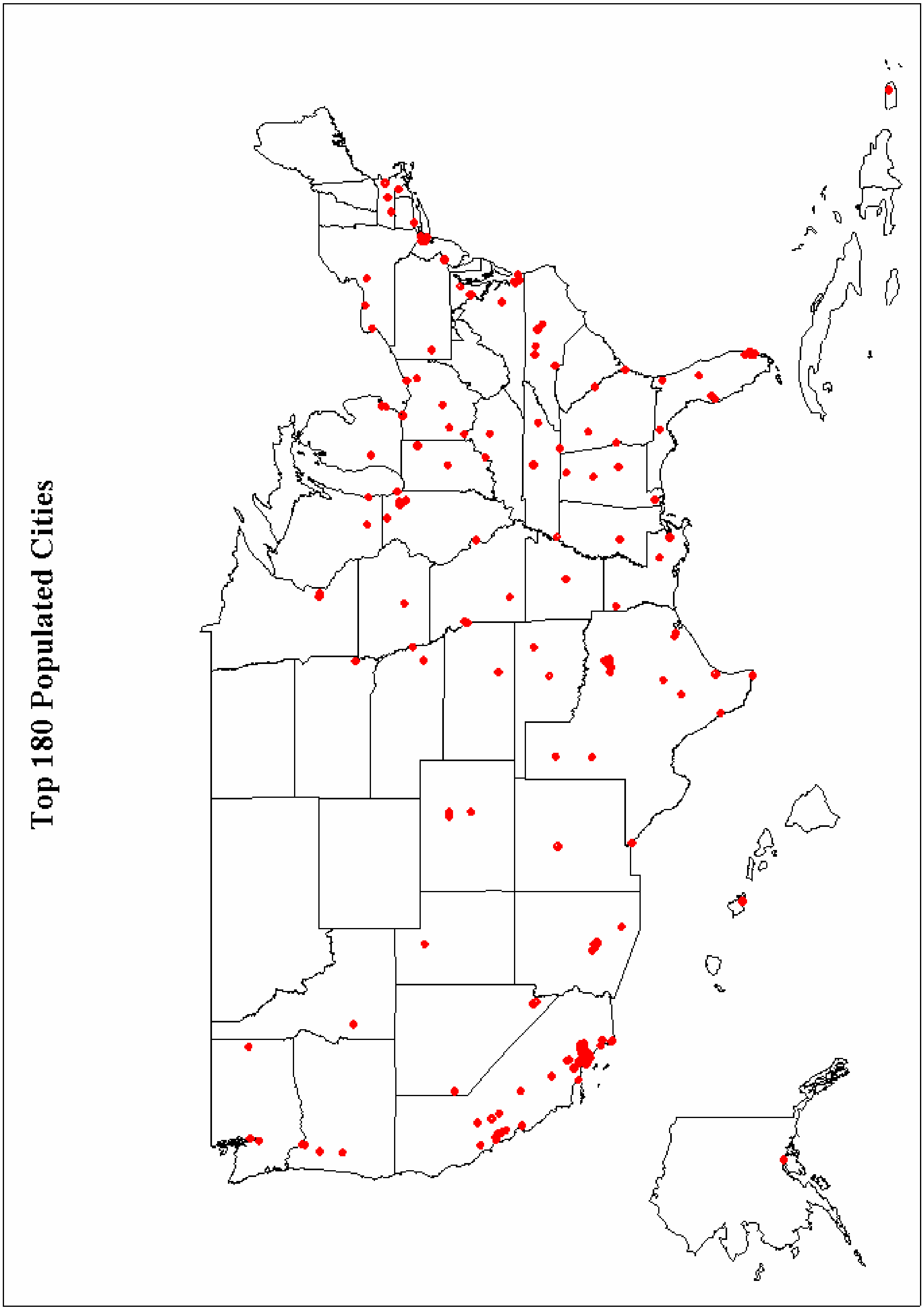


Fig. 3.6.2. 180 most populous cities.

2) The area-only based approach focuses on maximizing the geographical distribution of the monitors. It is consistent with the siting objective to provide modelers with a large number of distributed data points to reduce the uncertainties in their projected plume trajectories and health impacts assessments. One example of how this approach might be implemented would be to space monitors uniformly in a grid pattern across the U.S. with the number of nodes equal to the total number of monitors deployed (e.g., 180). This option would provide greater area coverage of the continental U.S., more data points for plume modeling and validation, and the best chance of detecting trans-border and global radiological incidents. However, in this configuration, many monitors would likely be placed in locations remote from major population centers, away from necessary infrastructure support and possibly operator availability. This, in turn, would lead to less information about the plume characteristics, radionuclide concentrations, and health impacts within the cities impacted.

   Another example of how an area-only based approach might be implemented would be to place monitors at locations suggested by atmospheric transport and dispersion modeling of computer-simulated release scenarios at selected target locations. Such an option would consider site-specific meteorological conditions, provide a semi-quantitative basis for assessing network performance, and focus resources where people and plumes intersect. However, like the grid-pattern, a design based on modeling may leave gaps in population coverage and limit city-specific health assessments. Section 3.6.3 discusses a proposal that explores this option further.

3) The population- and area-based approach focuses on designing a network that maximizes the advantages of the two previous approaches, while minimizing their disadvantages. It would come closest to meeting all of the siting objectives and design constraints and decisions, but its implementation might not be as straightforward. For example, one option would be to start by placing monitors in the largest cities in each state and in cities with populations exceeding a threshold size, e.g., 750,000. Fig. 3.6.3 illustrates how the network might look using this approach. Additional monitors would be sited to reach the maximum number allowed by the available resources (e.g., 180).

   Another option would be a multi-step process that initially places all the monitors in the top-ranked cities, identifies and removes clustered monitors, and places the excess de-clustered monitors in area gaps based on distancing criteria. Both options would be predominately population based, but would redistribute some fraction of the monitors to gain area coverage with little loss in population coverage.

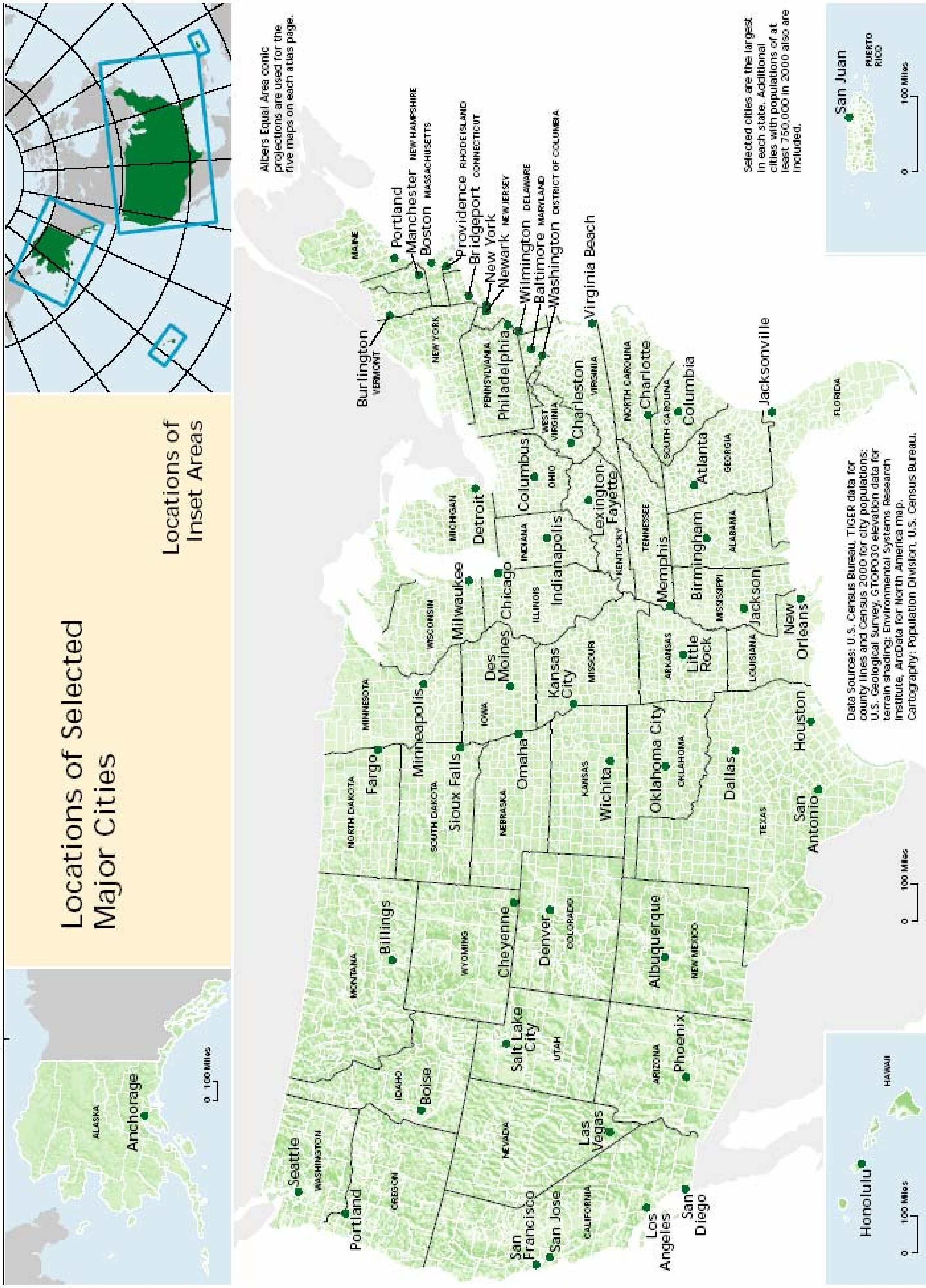


Fig. 3.6.3. Locations of selected major cities.

Other Design Considerations

Regardless of the approach selected, EPA recognizes that several additional practical considerations will come into play when siting monitors in specific locations, and that these may influence the network design. Many of these practicalities will be important to EPA's partners and may include issues relating to:

- Parallel development of siting plan and installation of initial monitors
- Flexibility in siting distance from chosen location
- Flexibility with respect to local siting criteria

Depending on the approach selected, some states may not receive a monitor primarily due to low-density populations, proximity to another site, remoteness, or some combination of these factors. EPA sees the value in a truly national network and to the extent possible has tried to incorporate area considerations into the siting plan.

Another practical consideration is the parallel development of the siting plan and the installation of the first monitors. As discussed in other sections of this document, EPA has purchased and is now receiving the first set of monitors from the vendor. As part of the implementation plan, EPA has selected locations in several major cities and is working with the EPA regions, states, and local operators to ready these sites for monitor installation. Although the national siting plan has not been finalized, EPA is proceeding with the installation of these monitors in a manner that is generally consistent with the Agency's selected siting methodology (see Section 3.6.2).

Lastly, EPA wants to ensure that the siting plan is flexible enough to accommodate partner preferences with regard to local siting decisions. For example, it is possible that EPA's siting methodology might select a specific location, while the future operators of that station might, for various reasons, prefer to place that monitor in another location nearby. Given the broad nature of the plumes being examined, EPA understands that, in certain cases, moving a monitor within some limited distance should not affect the overall value of that monitor to the network, and would work with the operators to reach an equitable solution. Similarly, if a specific site selected cannot be found or is less accessible to an operator, EPA might agree to move the site to another location within some limited distance.

3.6.2 Siting Methodology

The selected siting methodology has three basic steps. It begins with population as the primary criterion, identifies and removes monitors in close proximity, and re-distributes these monitors to fill gaps. The basic approach is as follows:

- Select the highest population cities for the number of monitors to be placed.
- Remove cities that are in close proximity to each others.
- Fill in the gaps.

Population Database

The siting methodology requires population data for numerous cities across the nation. Early in the development stage, EPA used Metropolitan Statistical Areas (MSAs) as the source for population estimates for its siting population database. However, after internal EPA review, MSAs were discarded due to the complexity and large variability in the sizes of areas involved. Instead, EPA decided on a more straightforward approach using city population estimates for all incorporated places in the U.S.

Estimates of incorporated city populations in 2004 were obtained from a U.S. Census Bureau website, http://www.census.gov/popest/cities/SUB-EST2004-4.html. Because of its size, San Juan, PR was also included in the population database. The 2004 population estimate for San Juan was obtained from http://www.census.gov/popest/municipios/PRM-EST2004.html. Once all of the population data were obtained from the tables, they were sorted in order of decreasing population. Cities with less than 25,000 people were omitted from further consideration to ensure that monitors would be placed in relatively high population areas. This resulted in a database of 1,323 candidate cities for monitor siting.

Step One

The first step begins with the identification and selection of the top-ranked, most populated U.S. cities, regardless of location. Fig. 3.6.4 shows a map of the top 180 locations.

Fig. 3.6.4 shows that there are several areas where cities are grouped or "clustered," mainly in the large metropolitan areas. As described earlier, the siting objectives require the system to spread across the nation, not to concentrate in metropolitan areas. For this reason, it is important to identify and "de-cluster" these areas, as described in the next step.

Step Two

A 25-mile (40 km) distancing criterion is used to de-cluster the monitors (the basis for this criterion is discussed toward the end of this section). If a city selected in step one is within 25 miles of a larger city, the smaller city is removed from the database. This de-clustering process results in the "removal" of 64 cities. Fig. 3.6.5 shows those cities that are removed by de-clustering (in blue) and those which remain after step two (in red).

Fig. 3.6.5 also shows large areas of the U.S. where no monitors would be located, i.e., gaps. Step three completes the siting methodology by selecting locations to fill those gaps.

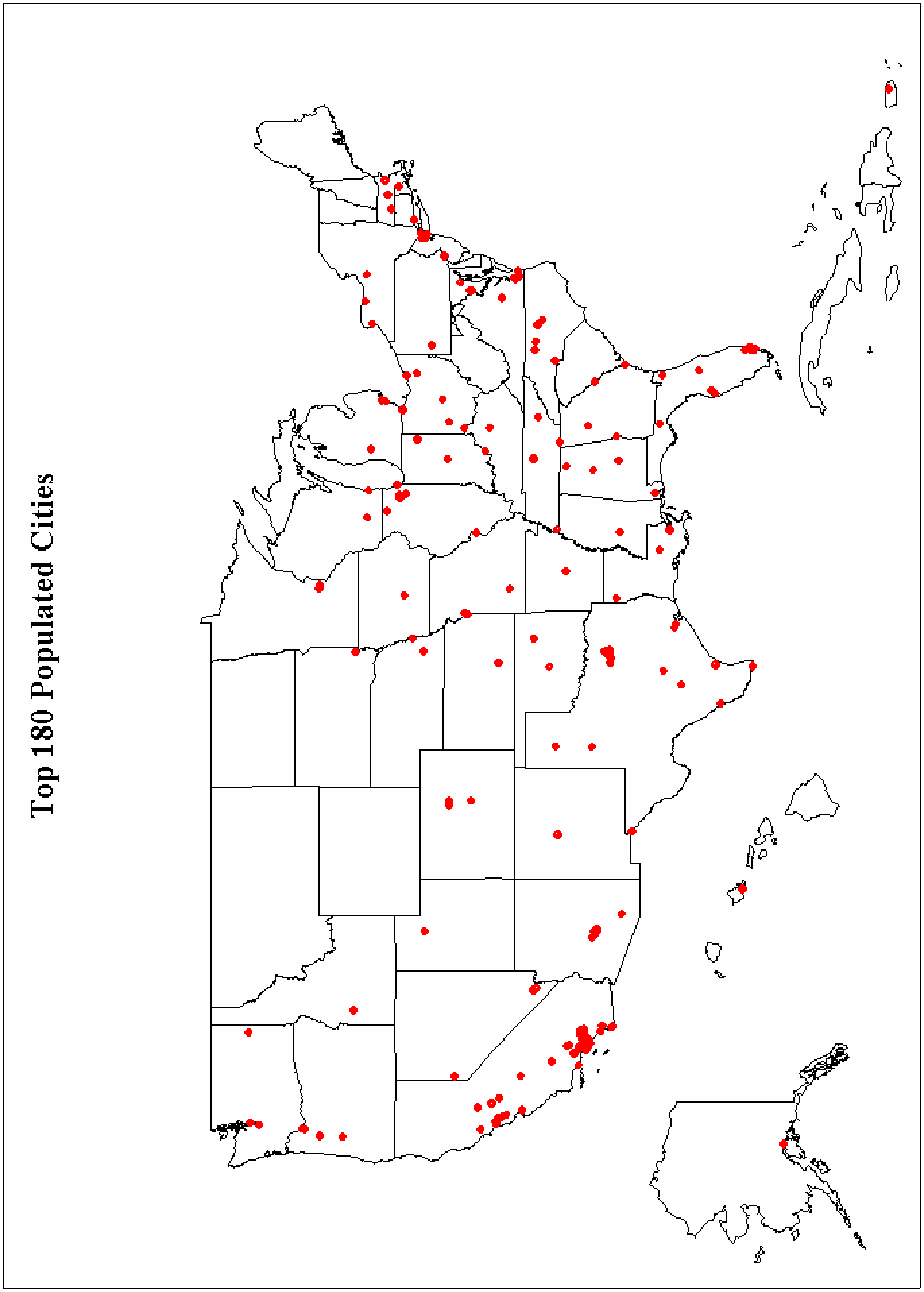


Fig. 3.6.4. 180 most populous cities.

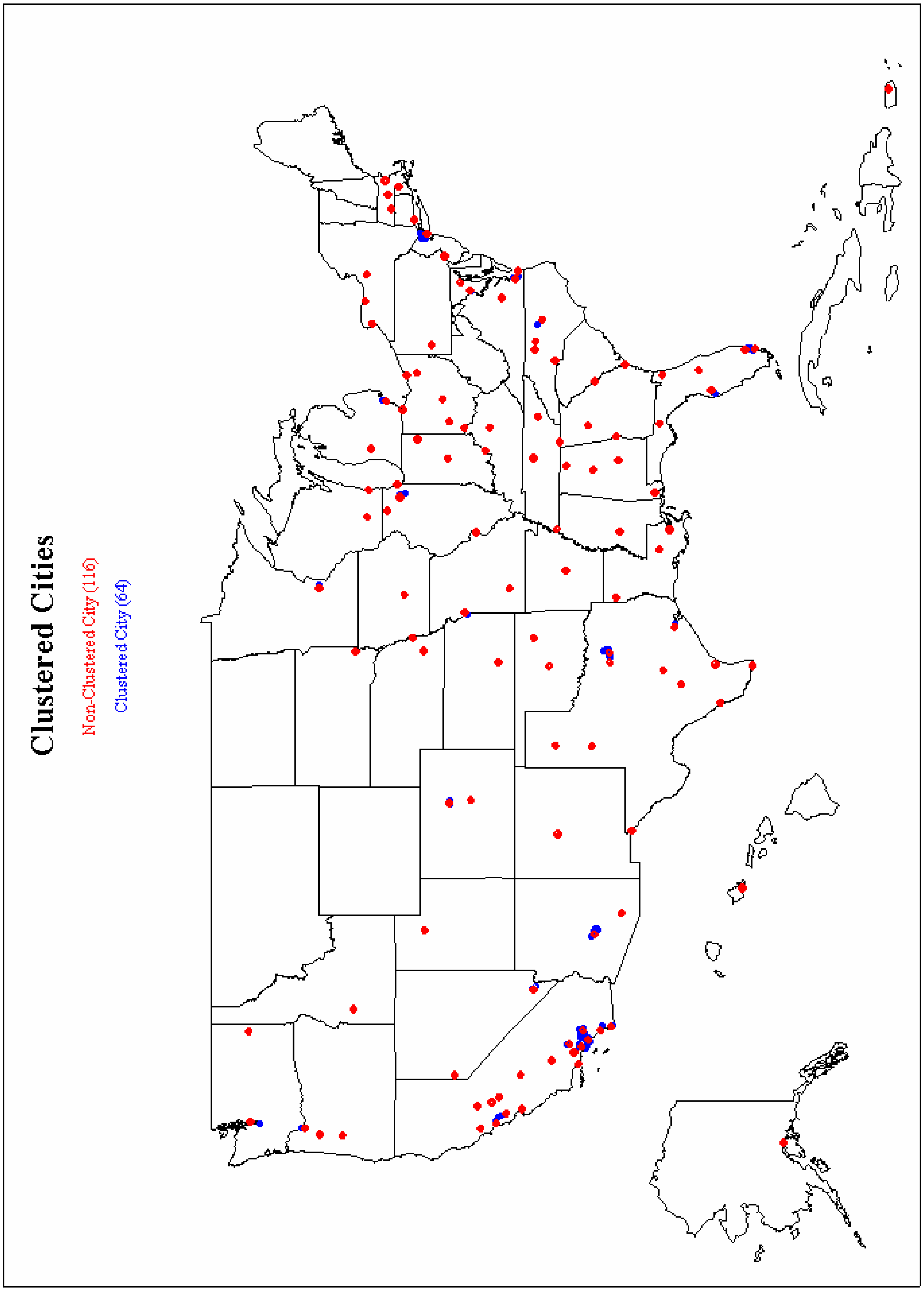


Fig. 3.6.5. Declustered cities.

Step Three

Step three fills in the gaps using an iterative process which considers distances between selected monitors and potential new locations, placing new monitors as far away from selected ones as possible. The process begins by selecting the largest “unmonitored” city (i.e., the largest city in the database not picked in step one or eliminated in step two), and then compares its distance from each “monitored” city (i.e., a city remaining after step two or added during step three). That distance is compared to a target distance, initially set at 600 miles (960 kilometers), since that is further than essentially any potential unmonitored city to any monitored city after step two.

If the distance between the unmonitored city and *every* monitored city is greater than the target distance, the unmonitored city is selected as a location. If the unmonitored city is closer to *any* selected city than the target distance, the city is not selected at this time. Then, the next largest unmonitored city in the database is tested, and the process repeats until all unmonitored cities in the database have been tested.

Once 180 cities have been selected, the testing ends. However, if 180 cities have not been selected after testing each unmonitored city, the target distance is lowered by one mile and the entire list of unmonitored locations is tested again. This process continues until 180 monitors have been sited. Fig. 3.6.6 shows a flow chart of the methodology, which is applicable for a range of values for the number of monitors. As previously noted, EPA anticipates a network of approximately 180 fixed monitors, thus 180 is used in the flowchart.

With those 64 locations, the system now has about two-thirds of the monitors in the largest cities (after de-clustering) and about one-third of the monitors located by area considerations. Fig. 3.6.7 shows the final results of the approach.

<u>Basis for the 25-mile (40 km) “De-clustering” or Distancing Criterion</u>

To obtain the distance that would determine if a city was too close (i.e., clustered) with a larger city, the Gaussian plume equation can be used to estimate a distance between monitors such that a plume isn’t likely to pass between the monitors.

The plume width is dependent upon many factors. The primary factor is the atmospheric dispersion in the crosswind direction. Gaussian plume models assume this to be a variable with respect to both downwind distance from the source and atmospheric stability. Thus, in order to determine appropriate plume widths, a distancing criterion must be chosen and a series of atmospheric stabilities must be analyzed.

Since the fixed RadNet system is designed to monitor for distant releases, a criterion for an appropriate distance is the distance where the vertical distribution of the contaminant is constant. This value will vary for each stability classification and mixing layer height, since the vertical distribution is very highly dependent upon those factors. This will provide a similar end point for each situation.

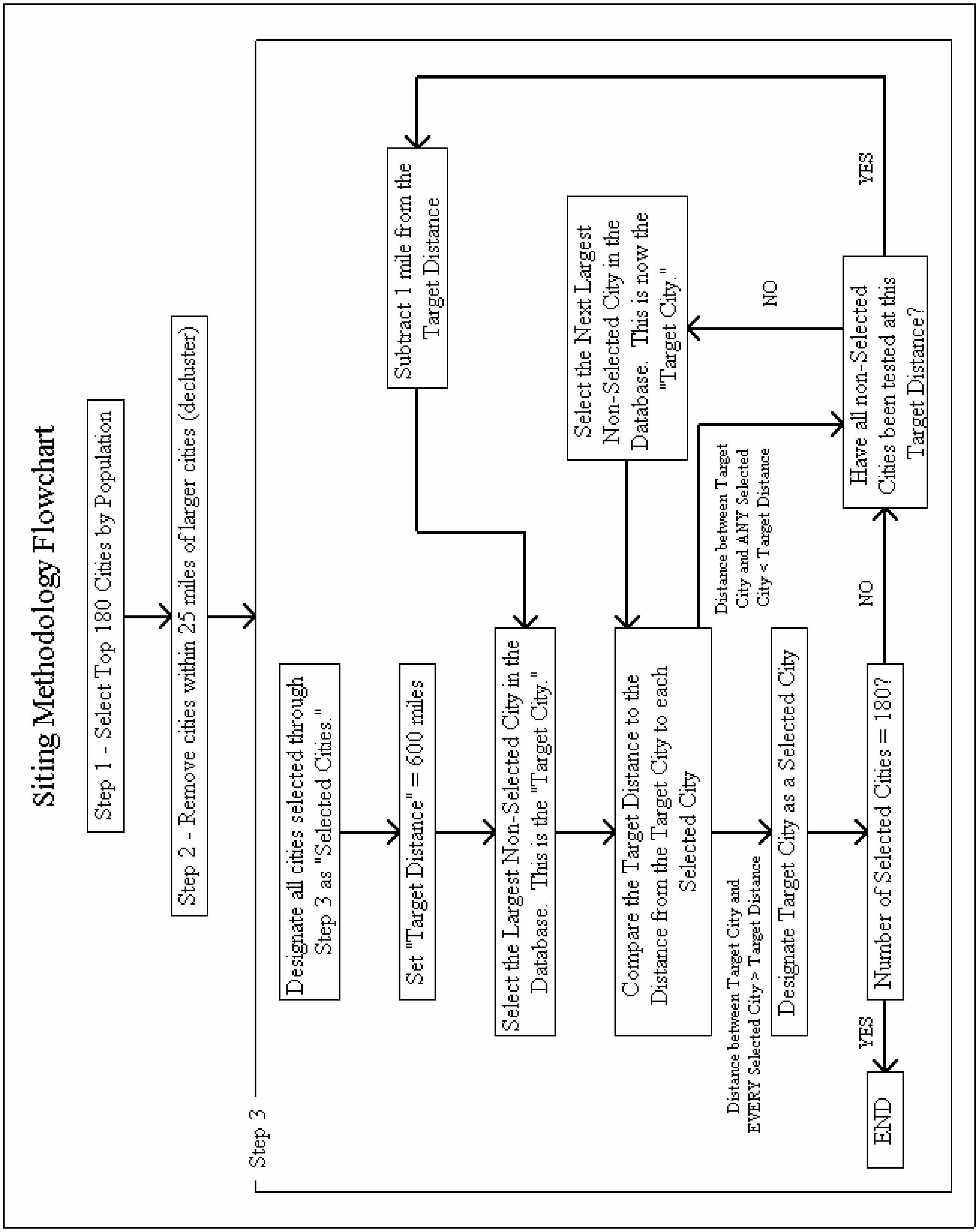


Fig. 3.6.6. Flow chart of the siting approach.

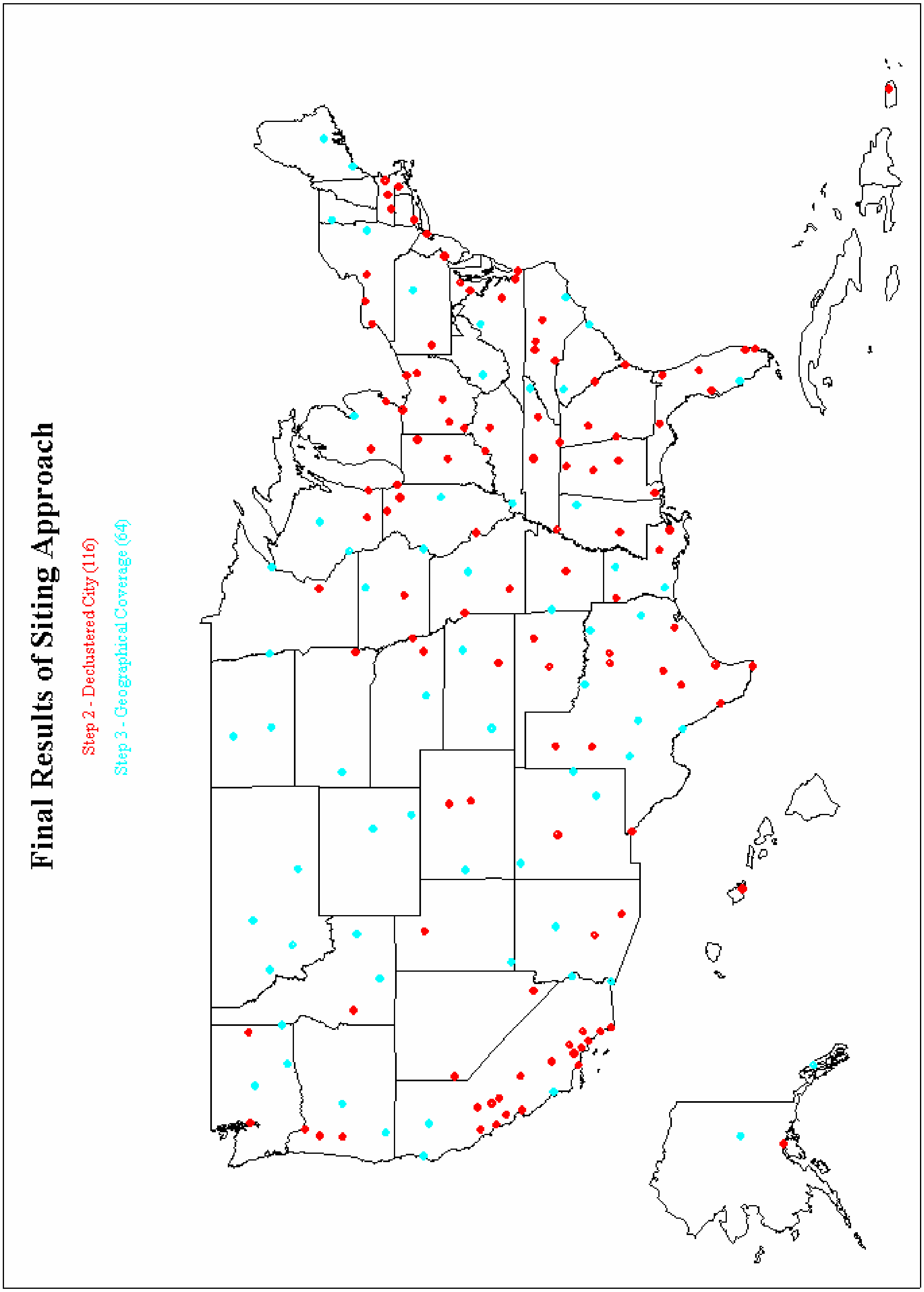


Fig. 3.6.7. Final results of the siting approach.

The process of determining the distance to the point where concentration is constant in the vertical direction begins with obtaining atmospheric mixing height data and the corresponding atmospheric stability. These data were obtained from http://www.epa.gov/scram001/tt24.htm#surface.

Turner [TUR70] discusses a methodology for use in Gaussian plume modeling which calculates the distance where the concentration of a plume can be considered constant in the vertical direction, from which the rest of the paragraph is taken. When the mixing layer height is 2.15 times the vertical diffusion parameter above the plume centerline (the maximum concentration line in the direction of transport), the concentration is approximately 1/10th of the centerline concentration. At this point, it is assumed that the mixing layer is forming a "lid" through which the plume cannot easily travel. Thus, it essentially becomes trapped between the surface and the mixing height. When a plume has traveled to the point where the vertical diffusion parameter is 0.47 times the mixing height (1/2.15), the plume can be said to begin being affected by the mixing layer. It is assumed that at a distance twice the distance where the plume begins to be affected, the vertical distribution becomes constant. Thus, the distance where the vertical concentration is expected to be constant is calculated using the following series of equations.

$$\sigma_z = cx^d = 0.47L$$

$$x = 2 * \exp \frac{\ln(.47 * L / c)}{d}$$

Where: σ_z = vertical diffusion parameter, m
c, d = constants for estimating the vertical diffusion parameter [TUR94]
x = downwind distance from source, m
L = mixing layer height, m

In Gaussian plume dispersion models, the distribution in the crosswind direction is described by a Gaussian equation in the "y" direction (y is the crosswind direction). This is the only part of a Gaussian plume equation where the crosswind effect is taken into account, and thus all other aspects of the Gaussian plume equation are constant. Setting the crosswind diffusion portion of the equation equal to 0.001 will provide the crosswind distance where the concentration is 1/1000th of the centerline (or maximum) concentration at this distance. This can be done from the following series of equations.

$$\sigma_y = ax^b$$

$$0.001 = \exp\left(\frac{-y^2}{2\ \sigma_y^2}\right)$$

$$y = \sqrt{2\ln(1000)\sigma_y^2}$$

Where: σ_y = horizontal diffusion parameter, m
a, b = constants for estimating the horizontal diffusion parameter
y = cross-wind distance from centerline, m
x = downwind distance from source, m

The edge of the plume is defined here as 1/1000th of centerline concentration, based on the assumption that the centerline of the plume is the concentration of Cs-137 (0.27 μCi/m^3 or 10000 Bq/m^3) which will yield one rem (0.01 Sieverts) in four days (PAG [EPA 92] early phase action level). Cs-137 was chosen because it is applicable to nuclear fission events (reactor or weapon) and potentially RDD events as well. Over a 24 hour period, a sampler at the centerline would collect 50800 ft^3 (1440 m^3) of air, and about 389 μCi (14.4 MBq) of Cs-137. The specified minimum detectable activity of Cs-137 for the fixed monitors is 3 μCi (111 kBq) (see Section 3.3). Testing of the fixed prototype monitor indicates the minimum detectable activity will be orders of magnitude below the specification, but EPA conservatively assumed it to be 1/10th of minimum specifications, or 0.3 μCi (11 kBq). Thus, the detector can detect 1/1300th of the level required to reach the PAG. If a detector is located at a point downwind where it will collect this activity, that point will be where the concentration is 1/1300th (rounded to 1/1000th) of the PAG level, which is conservatively defined as the edge of the plume for this approach.

An average plume width can be established for each set of atmospheric transport conditions associated with a city. Stability classification and mixing height data were obtained for 14 cities located across the continental United States in order to determine an approximation for the width of a plume using the equations above. Values of cross-wind distance for the atmospheric conditions for each hour and city were averaged. The average plume width was determined to be approximately 50 miles (80 km) at the distance where the vertical distribution becomes constant. The 25 mile (40 km) de-clustering distance is based upon the centerline to edge distance of the plume, or one half of the plume width. It should be noted that Gaussian Plume models generally underestimate plume spread in the cross-wind direction at long distances from the source since wind direction changes are not accounted for in simple Gaussian Plume models. It is most likely half the plume width as defined here would be wider than 25 miles (40 km).

<u>Method Sensitivity to Variation in Number of Monitors and De-clustering Distance Rule</u>

As noted previously, the methodology described above needs to be flexible with respect to the ultimate number of monitors. Sensitivity analyses of population and geographical proximity have been performed to demonstrate the effects on the methodology for various numbers of monitors.

Population Metric

Estimates of population near a monitor are made using ArcGIS software [ESR 05]. The population metric for the sensitivity analysis is the number of people within 25 miles (40 km) of a monitor. Twenty-five miles was chosen as the radius since that is half of the average plume width calculated, as described earlier. Note that there is no implication that a person or persons is “covered” or “monitored” at any specific distance or location. The ArcGIS software does not double count people if two or more monitors have overlapping radii.

Geographical or Area Metric

The geographical metric is a number that represents the percentage of “area coverage” of the approach being tested against a grid of the continental United States that would provide 100% area coverage for 175 monitors (180 monitors minus three for Alaska and one for Hawaii and Puerto Rico). The analysis tests over 80,000 grid points across the continental United States, looking for the percentage of grid points that fall within 98.3 miles (157.3 km) of a monitor. The 98.3 mile distance is based on half of the maximum distance between two points after establishing a grid of 175 monitors across the continental United States (139 mile or 222.4 km grid). Fig. 3.6.8 provides a physical representation for the 139 mile grid and the 98.3 mile distance and an example of how the geographic proximity estimate is performed.

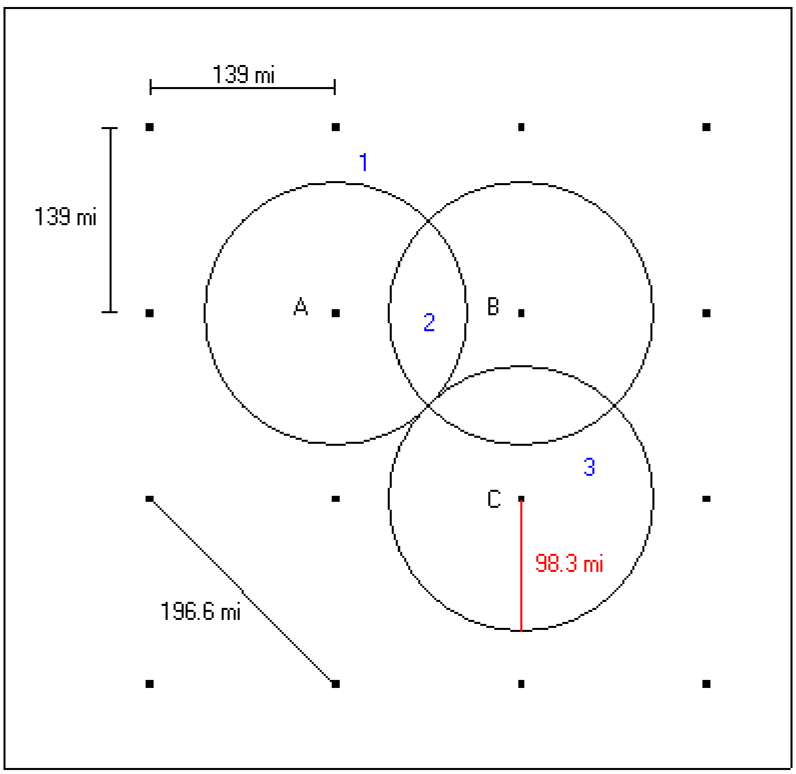


Fig. 3.6.8. Demonstration of geographic proximity metric calculations.

In Fig. 3.6.8, a 139 miles grid is shown. In the example, there are three monitors, A, B, and C. Each monitor has the 98.3 mile circle for geographic proximity. There are also three example points for evaluation to the proximity of a monitor. In this case, point 1 is not within 98.3 miles of a monitor, point 2 is within 98.3 miles of two monitors, and point 3 is within 98.3 miles of one monitor. Therefore, if this was the geographic proximity estimate, there are two of three tested points that are within 98.3 miles of a monitor (point 2 shows that being within 98.3 miles of two monitors is no different than being within 98.3 miles of any monitor in this metric). Since two of three test points are within 98.3 miles, the geographic proximity percentage would be 66.7%.

Results of Sensitivity Analysis

The first sensitivity analysis was performed for varying numbers of monitors. Systems ranging from 30 to 240 monitors were analyzed. Table 3.6.2 shows results for population and geographical proximity for the selected number of monitors. Fig. 3.6.9 shows a graph of geographical and population proximity versus number of monitors.

Table 3.6.2 Population and geographical proximity for various numbers of monitors

Number of Monitors	Population Proximity (%)	Geographical Proximity (%)
30	27.9	19.8
60	39.6	36.7
90	44.1	54.1
120	48.1	68.6
150	52.6	77.3
180	56.1	81.8
210	59.3	82.3
240	61.9	83.6

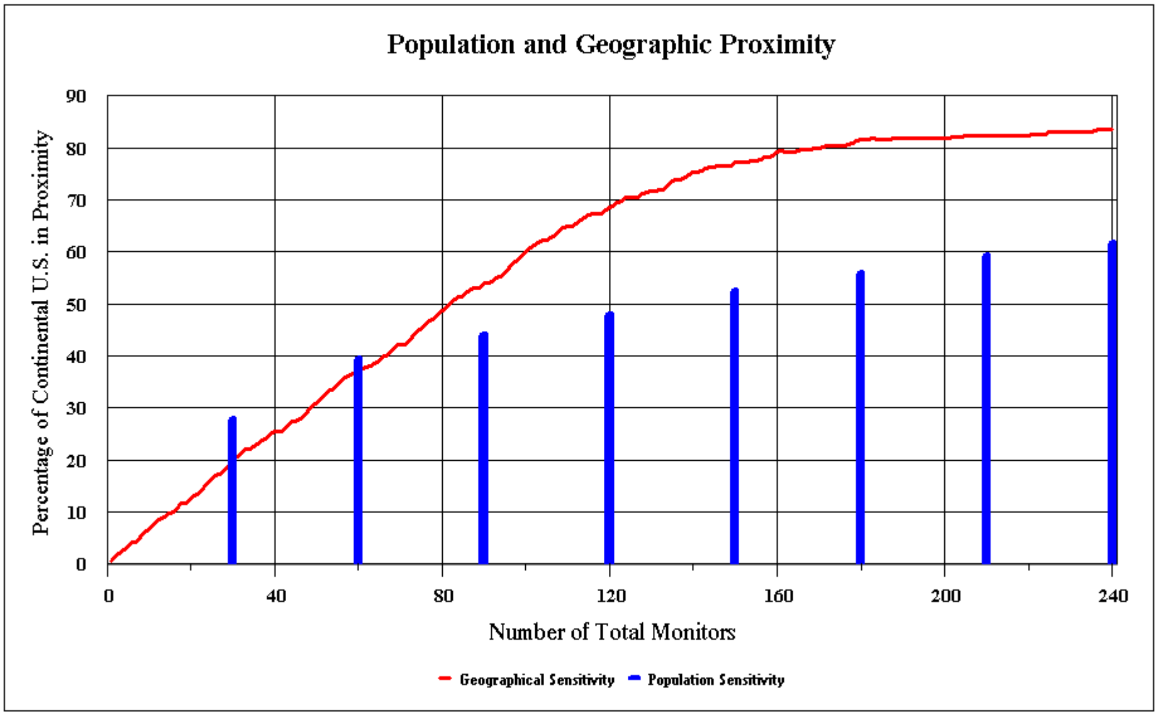


Fig. 3.6.9. Geographical and population proximity versus number of monitors.

As can be seen from Fig. 3.6.9, geographic proximity increases rapidly at the lower number of monitors, then flattens out at the higher numbers of monitors. At just over 180 monitors, the geographic proximity measure begins to flatten.

Population proximity begins much higher than geographical proximity because of the large populations of the highest cities and because the methodology is population driven at lower numbers of monitors. The rate of change in population proximity with respect to number of monitors is, in general, much smaller than the rate of change in geographical proximity, except as noted where the geographical proximity begins to flatten.

Another sensitivity analysis that was performed reviews which criteria are used and in what proportion. Fig. 3.6.10 below shows the breakdown of monitors sited by population (step 2) and those sited by area coverage (step 3).

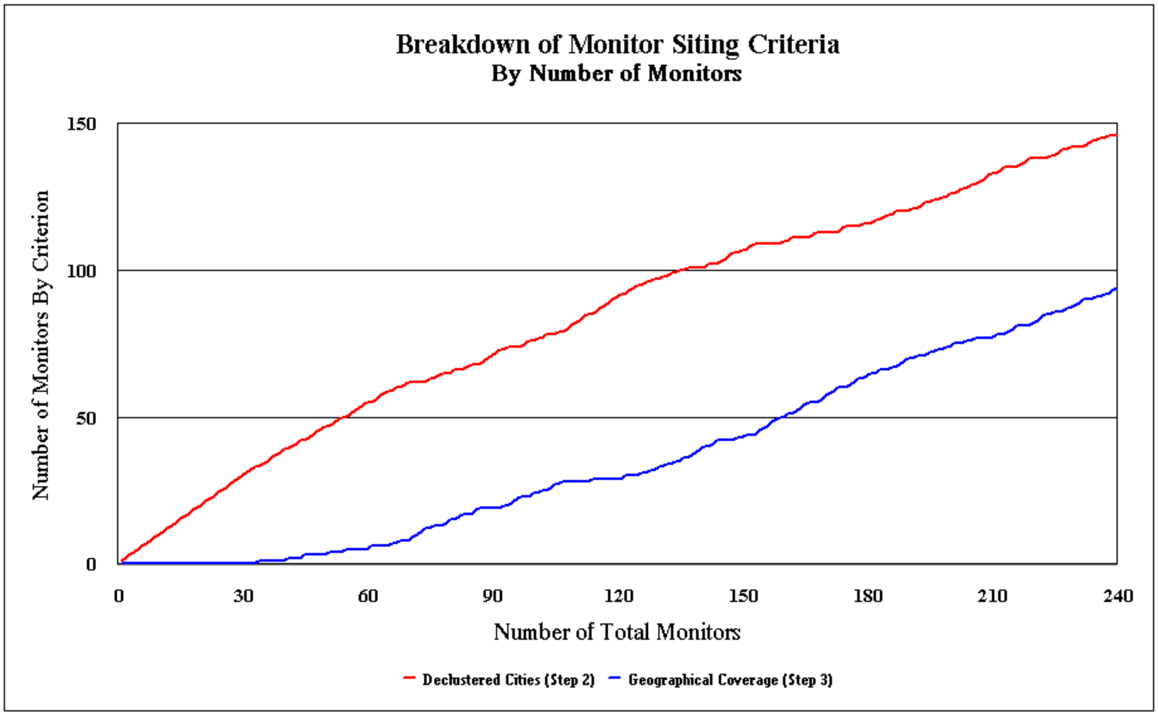


Fig. 3.6.10. Breakdown of monitor siting criteria.

Fig. 3.6.10 shows that the methodology is completely population driven up to the point where 34 monitors are placed. Since EPA already has a contract for 51 units, there will be enough monitors for the methodology to address both population and geographic considerations within the next year.

By running the methodology for each number of monitors from 1 to 240, EPA is able to show how some locations are likely to be included in the final list almost regardless of the number of monitors. For example, New York, Los Angeles, and Chicago will always be the first three cities selected, and will never be de-clustered from one another. Thus, it is reasonable to place monitors in those cities since they are independent of the final number of monitors.

A decision made by EPA early in 2005 was to place monitors in the 60 largest metropolitan areas first. This decision was based on EPA's desire to install monitors into the field and enhance readiness as soon as possible. Since EPA did not want to store monitors, it requested that the vendor ship monitors directly from their facility to the monitoring location and to provide setup service. EPA needed to identify an initial set of locations to prepare sites (a process that can take several months), and thus selected the top 60 metropolitan areas, which were not expected to change unless the siting methodology at that time was significantly changed.

As noted earlier, the plan of using Metropolitan Statistical Area populations was discarded due to the complexity and large variability in the sizes of metropolitan areas. The ultimate use of city jurisdiction rather than MSA did not have a major effect on the initial decision to site the first 60 monitors in the 60 largest metropolitan areas. If the number of monitors is assumed to be 180 as expected, only six metropolitan areas that were in the initial Top 60 List are not listed in the plan under the current methodology. Fig. 3.6.11 shows a breakdown of how the "first 60" compare with the results of the methodology as a function of total number of monitors.

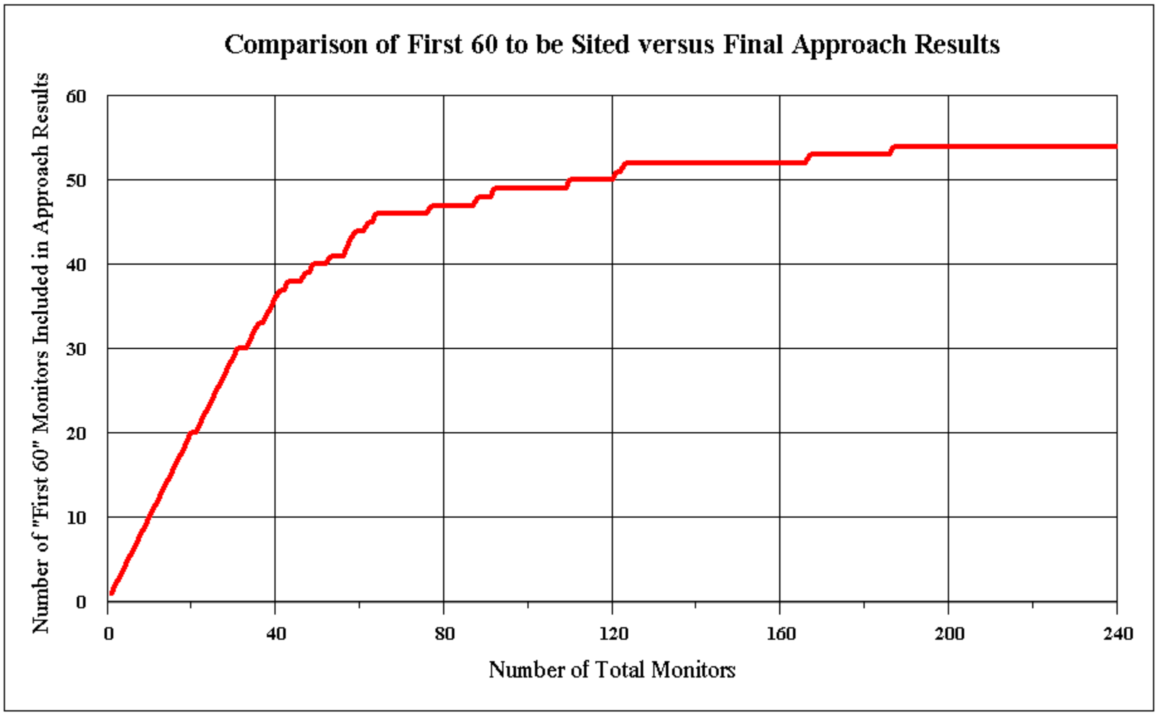


Fig. 3.6.11. Comparison of first 60 to approach results.

The current approach uses a 25 mile (40 km) de-clustering distance, which is based upon average plume width from centerline to edge. EPA also considered using a 50-mile (80 km) de-clustering distance, which would represent one edge to the other. This would provide greater spreading of detectors in major metropolitan areas with more than one large city (e.g., Los Angeles). However, since 25 miles is based on an average of numerous plume calculations, EPA felt it was best to remain conservative and allow greater monitor density in large metropolitan areas. EPA compared the population and geographical proximity for the 25- and 50-mile de-clustering rule for a 180 monitor network. Table 3.6.3 and Fig. 3.6.12 show results for this comparison.

Table 3.6.3. Comparison of 25- and 50-mile de-clustering rule for 180 monitors

De-clustering Distance	Population Proximity (%)	Geographical Proximity (%)
25 miles	56.1	81.8
50 miles	49.8	82.4

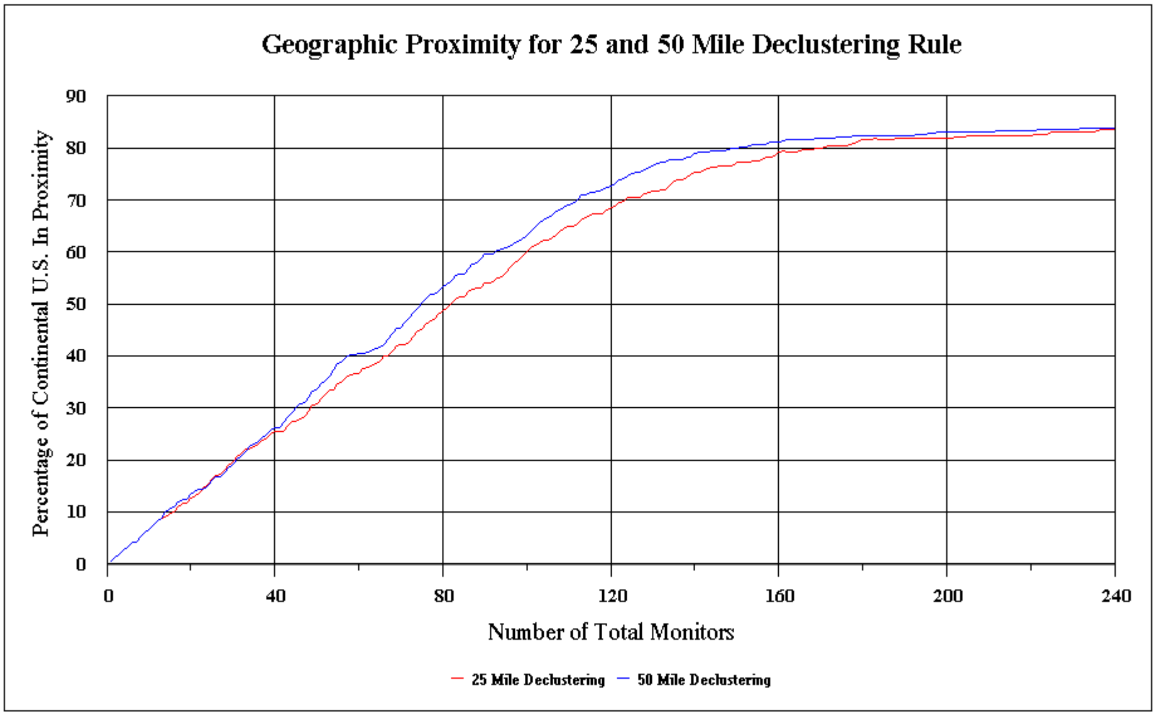


Fig. 3.6.12. Geographical proximity comparison for 25- and 50-mile de-clustering rule.

Table 3.6.3 and Fig. 3.6.12 show that de-clustering at 50 miles (80 km) increases the geographic proximity metric somewhat, particularly between 40 and 200 total monitors. However, at the expected 180 monitors, de-clustering at 50 miles does not significantly increase the geographic proximity metric, but it does significantly decrease the population proximity metric.

3.6.3 Confirmation Atmospheric Dispersion Modeling

EPA is evaluating the utility of an atmospheric dispersion modeling approach to assess the siting methodology described previously (see Appendix L). EPA is considering assistance from the Savannah River National Laboratory (SRNL) to perform atmospheric dispersion modeling that would more explicitly optimize monitor locations [KUR05]. As stated earlier, modelers have more need for data based on geographic placement rather than population placement. This will test the methodology's geographical placement capability.

The study will project detection probabilities for a grid of locations throughout the U.S. These detection probabilities can be "overlaid" on a map of selected locations to determine if areas of high probability of detection are unmonitored, or, if areas of very low probability of detection are monitored. The results of the SRNL project will be compared to the results of the previously described methodology and weighed against the stated objectives of the RadNet system.

The general methodology to be deployed by SRNL begins with the establishment of a coordinate grid for plume evaluation. The grid will consist of 30 mile (48 km) spacing, except in high population density areas, where the grid will be reduced to 10 mile (16 km) spacing. Each grid point will be assigned a population based upon population density data.

Next, source locations will be determined. These will include large population areas, defense, and civilian facilities. Somewhere between 20 and 60 locations will be chosen as part of the project. Release probabilities will also be assigned to the locations, based upon probability of an event at that location or the importance of that location.

Once the location is determined, the release information is selected (release height, composition, etc.). An explosion (instantaneous release, or "puff") will be assumed with less than one hour emission time.

Because atmospheric dispersion varies significantly based on time of day, weather conditions, seasonal conditions, etc., the simulation times will be selected randomly. Approximately 20 release times for each season of the year will be selected, providing a total of 1600 to 4800 plume simulations.

These parameters will be input to the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model (DRA97). The model will determine average particulate concentrations over time during the model simulation at the various grid points selected for evaluation.

Since the project with SRNL is in the concept phase, further details of the project are not available, nor are details of the expected results. SRNL has proposed performing a small portion of the project as part of a pilot project to allow EPA the ability to see preliminary results and to provide comment to ensure the results will meet EPA's needs

3.6.4 Fixed Monitor Siting Conclusion

The discussion above describes a methodology to site a national network of fixed monitors to meet EPA's objectives both during on-going operations and emergency circumstances. This methodology focuses on protecting public health by providing analysts, modelers, and emergency response officials timely, monitored information measuring large-scale atmospheric releases of radiation in the environment.

EPA has sought a transparent network design that is fundamentally based on technical and scientific objectives, that provides flexibility consistent with the network's goals and at the same time reflects practical and real world considerations. A strong emphasis on large population centers guided the development of this methodology with the recognition that other factors, particularly geographical coverage, are important to the network design. Confirmatory approaches were also identified to consider additional elements such as meteorology and incident scenarios.

Of particular note is the degree of flexibility that is important and necessary to any network design. Flexibility with respect to precise monitoring locations remains consistent with the network's goals by recognizing the large-scale nature of the plumes EPA seeks to measure. Relocating any particular monitor some limited distance should not undercut its value or the value of the network as a whole. Such flexibility, in turn, provides a means for practical considerations to be taken into account – considerations that include locations accessible to the volunteer operator; locations that meet local siting criteria; and locations already identified through EPA's implementation efforts to date.

The interplay of implementation and design has been a major feature of the RadNet project since its inception. Given the high priority placed on homeland security and emergency preparedness, EPA has not waited for the overall network design to be complete, but rather has, in a parallel fashion, developed the new monitor instrumentation and selected an initial subset of monitoring locations that EPA believed would be included in any siting plan. These locations generally reflect the top sixty most populous metropolitan areas in the United States. EPA intends to site monitors at these locations where implementation efforts are far along. To the extent that such locations deviate from the more theoretical design, that design will accommodate these limited number of locations. EPA's initial implementation list (its "top 60") and the network suggested by the approach described in Section 3.6.2 identify four (4) such locations. These four locations are Edison, NJ; Hartford, CT; San Bernardino County, CA; and Suffolk County, NY.

Such flexibility is important, but needs to be bounded for the integrity and the principles of the RadNet system to remain. Exceptions will be limited to ensure the mission and objectives of the system are met. Therefore, in addition to this overall design, EPA intends to develop appropriate guidance for Regions and States as they assist us in the actual installation of monitors – guidance that will advise decisions regarding exact monitor locations. For example, given our "de-clustering" of monitors initially intended for smaller cities within 25 miles of larger cities, EPA modified the chosen locations of a certain number of monitors to other locations in the United States (the approach's Step Two and Step Three). Similarly and as an example, altering the sites of a small number of monitors within 25 miles of the design's suggested locations should not negatively impact the utility of that monitor or the overall network. EPA will continue to work on such guidance, and will evaluate alterations on case-by-case basis.

As the design is reviewed and as EPA gains experience in siting and installing monitors, it will continue to refine these designs, engage stakeholders on their implications and adjust the network accordingly. With a technically based design and an appropriate degree of flexibility, the network when fully installed should enhance the nation's ability to collect timely, monitored data for potential radiological incidents.

3.7 Local Siting Criteria

Selecting the optimal monitoring location will ensure that representative air particulate samples are collected for analysis. Criteria for local siting were developed by first searching for existing standards for selecting sampling locations for particulate matter in air, then reviewing and evaluating those standards for relevance. The conclusion reached after this evaluation was that the guidelines for selecting air sampling locations in EPA's regulations in Title 40 Code of Federal Regulations, Part 58, *Ambient Air Quality Surveillance* (CFR04), and EPA Guidance for Network Design and Optimum Site Exposure for PM2.5 and PM10 (EPA97) were both relevant and appropriate to use as a basis for sampling radioactive particulates. The 40 CFR 58 criteria were further reviewed and evaluated by staff from EPA's Office of Air Quality Planning and Standards, and by a consultant (ICF05b; see also Appendix G), for relevance to real time monitoring of radioactive particulates in air, and modified as appropriate. The resulting criteria that will be applied to local site selection for the fixed air monitors are:

- Access to the sampler should be controlled.
- Practical factors, such as prevention of vandalism, security, and safety precautions, must be considered in locating the sampler.
- The sampler should be kept clear of excessive dust or other materials that may prevent or inhibit air flow.
- There should be unrestricted airflow in an arc of at least 270° around the sampler.
- The space available for the sampler should be at least 16.4 feet (5 m) distant and in the upwind direction from building exhausts and intakes.
- The sampler should be placed at least 6.56 feet (2 m) from walls or other structures that might influence air flow.
- The sampler should be located away from obstacles, such as buildings, so that the distance between obstacles and the sampler is at least twice the height that the obstacle protrudes above the sampler.
- The sampler should be at least 164 feet (50 m) from busy paved highways in order to remain outside the road's immediate zone of influence.
- The sampler should be at least 6.56 feet (2 m) away from any other air sampler intake.
- Sampler inlets should be sufficiently distant (>32.8 feet [10 m]) from public access to preclude sample bias from deliberate contamination.
- The sampler should not be located in an unpaved area, unless there is vegetative ground cover year round, so that the impact of wind blown dusts will be kept at a minimum.
- The space available for installation must accommodate the physical dimensions and minimum clearances identified on the monitor installation drawings.
- The monitoring site should be evaluated for potential impact from nearby sources of gamma radiation that might interfere with the real time detector, or of radioactive particulate emissions which may bias the sample.
- The site should be evaluated to ensure that the necessary electrical power and telecommunications services are available.

- The site should be evaluated to determine if satellite line of sight is open.

3.8 Station Operators

In the event of a nuclear incident, it is of paramount importance to have a dependable and adequately trained network of collectors. Since EPA began operating the air monitoring network in 1973, air station operators have been provided mainly by state and local government agencies. EPA supplies all monitoring equipment and supplies to the stations but has not provided monetary support for the time and effort expended by the operators.

Current OMB reports for the ERAMS/RadNet air monitoring network estimate operator expenditure of time to be 75 person-hours per year. This estimate is based on station operators collecting air filters twice per week. Because the station operators would perform daily sampling in the event of a nuclear incident, this effort can increase significantly in a short time. Also, the installation of commercial air sampling equipment with additional quality assurance requirements will increase the amount of time required of operators.

Throughout the years, some stations have been re-located, and some agencies have decided to stop operating stations. EPA personnel have been responsible for locating new station operators willing to participate in the program. In general, EPA has been successful at retaining air station operators and persuading state agencies to participate in the air monitoring network. With the rapid expansion of the air monitoring network in the near future, EPA has partnered with the Conference of Radiation Control Program Directors (CRCPD) to help identify new station operators.

Air station operators have the *ERAMS Manual* (EPA88), which contains standard operating procedures for the air monitoring network. As equipment upgrades are being implemented, a training CD-ROM is being produced to instruct operators on equipment operation and quality assurance procedures. Because station operators are located throughout the United States, a CD is a cost-effective means of training. Operator training also includes emergency preparedness exercises to ensure operators are notifiable by phone and knowledgeable regarding sampling procedures following an alert.

3.9 Fixed Station Operations and Maintenance

Preparations for fixed station installation and setup include provisions for:

- Supporting and anchoring the monitoring station (e.g., a concrete pad with anchor bolts or wooden platform for ground-level installation, a pallet for rooftop installation, etc.);
- Electrical and telephone utilities; and
- Connection to a ground for lightning protection.

After site preparations are complete, a monitoring station will be shipped directly from the factory to the installation location. A factory service representative will travel to the site, set up the equipment, perform an initial calibration, and train the operator on operation and user-level maintenance.

The monitoring stations are intended to be recalibrated periodically at their installed locations. The station operator is given a calibration kit containing transfer standards and all other necessary equipment. An instrumentation technician will coordinate by telephone with the station operator to provide calibration data and any necessary adjustments. The station operator will assist by placing and removing standards and accessory equipment, taken from the calibration kit, as directed by the instrumentation technician.

During normal conditions, the monitoring stations will operate continuously except for the few minutes required approximately twice a week for the local operator to change the filter media. During sample collection, the radiation measurement instruments will monitor the filter continuously over programmable intervals for radioactive material. At the end of each measurement interval, the full gamma spectrum and gross beta counts will be stored locally, and a new measurement cycle will automatically begin.

After each filter change, the operator will record the sample collection start and stop dates and times and the total volume of air that has passed through the filter. After waiting at least five hours for radon progeny to decay, the operator will perform gross beta and alpha counts on the filter, calculate the gross activity, and mail the results to NAREL. When received at NAREL, each filter will again undergo a gross beta count. Measured (at NAREL) gross beta activity greater than 1 pCi/m^3 is investigated by gamma spectrometry or other appropriate methods.

The fixed monitoring stations will be covered by a one-year factory warranty for parts and labor. After the first year, they will be maintained through a service contract managed by NAREL. The services will include telephone troubleshooting and technical support for the operators, routine calibration and preventive maintenance, and troubleshooting and corrective maintenance as required. It is currently anticipated that the initial intervals for periodic calibration will be one year, with quarterly calibration verification, but these intervals may be adjusted based on experience.

4 DEPLOYABLE MONITORS

A deployable monitor is a nearly 270-pound unit that measures environmental gamma radiation levels in near real time, and also collects airborne radioactivity samples for laboratory analysis. The unit can be split up into its components, each of which weighs less than 60 pounds. The 40 deployable monitors will be stored, ready to deploy, at NAREL and R&IE and will be set up downwind or around the scene of a radiological incident or in case of an imminent threat. The deployables support the RadNet mission by improving system coverage in emergencies.

4.1 Equipment Description

Each deployable monitor consists of the following components:

- The low-volume air sampler component is a manually controlled air sampler that uses a venturi flow measuring device to electronically record the parameters associated with the collection of the sample. The sampler operates at a flow rate between 0.5-4.0 standard cubic feet per minute (SCFM) (14-115 standard liters per minute (SLPM). This sampler is designed to draw air through a 2-in (15 cm) glass fiber filter to collect particulate matter from 0.3 to 10 microns equivalent to EPA-2000 (PM10) criteria per nuclear industry standards and through a sample cartridge placed behind the filter to collect radioactive gases. The filter head is at 60 inches (1.5 m) above the ground at the breathing zone. The sampler is inside a weatherproof housing and all components are easily removable by quick-connect pins.

  The venturi flow measuring device monitors the barometric pressure, temperature, and flow rate. The sample parameters are calculated by the digital electronic module (DEM) and sent to the data logger to be transmitted via satellite telemetry at pre-set time intervals dictated by authorized personnel, or via manual download by the operator. Recorded data consist of the current, minimum, maximum, and average flow-rate in SCFM; sample volume in SCF; and associated temperature and pressure values associated with the sample.

  Minimum detection limits for the component will be based on the flow rate and sampling time used according to the sample detection limits established by the counting laboratory. These parameters (sample time and flow rate) will be predetermined depending on the minimum detection limits based on the data quality measurement objectives established by the command and control functions of the organization and will be transmitted to the operator of each individual system upon deployment.

- The high-volume air sampler component is an electronically controlled sampler that uses a venturi-flow measuring device and a feedback loop to regulate airflow through the system to a preset rate of between 20-50 SCFM (570-1415 SLPM). This sampler is designed to draw air through a 4-in glass fiber filter to collect particulate matter from 0.3 to 10 microns equivalent to EPM-2000 (PM10) criteria, per nuclear industry standards. Higher flow rates allow for lower detection limits and much shorter sampling times for quick turnaround of data in comparison to the low-volume sampler.

Other capabilities and parameters are the same as those described above for the low-volume air sampling component.

- The gamma radiation monitoring component is a Genitron Gamma Tracer with two compensated GM detectors that are in continuous operation. The detectors are capable of indicating levels from 2 µR/h (20 nSv/h) up to 1 R/h (10 mSv/h). The minimum accuracy requirement for gamma measurement data was established initially to be within ±15% at the low end, and ±10% at the upper end of a measurement range of 50 µR/h (0.5 µSv/h) to 80 mR/h (0.8 mSv/h) exposure rates, per ANSI N323A 1997. The instrument is calibrated to Cs-137 and has an energy response of ±20% between 60 keV and 1,000 keV. The units typically are set to store values in conventional units. The only parameters that are adjustable through interface with the setup functions of the gamma exposure instrument are the data-reporting format, in conventional or international units, and the data-averaging time, between 1 and 30 minutes. A 10-minute averaging time would be typical for this preset, although this is an event-specific value. The longer averaging times result in data values that are significantly more precise. The instrument is positioned 39 inches (1 m) above the ground. Gamma-exposure data are sent to the data logger for satellite transmission at pre-set time intervals, which are dictated by authorized personnel.
- The power distribution panel contains a 115–120 volt, 60 Hz power distribution center with a single power feed. The distribution center has four outlets, giving each component an individual protected circuit. The deployable can be plugged into a U.S. standard household outlet (115–120 volt, 60 Hz, with 20 amps maximum) with total station draw not to exceed 20 continuous amps. A 25 feet (7.6 m) power cord rated at the maximum power draw is attached and hardwired to the power distribution center.
- The satellite telemetry uses an external antenna placed 8 ft (2.4 m) above ground. Information is routed from the deployable station to an Iridium satellite and then down to the NAREL FTP server.
- The data logger has three redundant ways to collect data: satellite upload to the FTP server, conventional analog phone line, or download to the personal digital assistant (PDA). The data logger controls the sequence of events for each external device. It captures critical data and saves it for up to 30 days. In the event of a power loss, data will be stored for 24 hours.
- The PDA is used to send setup files to the data logger. The setup file is created prior to the deployment to dictate all parameters for the components to start, collect, send, and store data. The PDA also can be used to download data.
- The GPS unit stores and captures the real-time unit location given in latitude and longitude (in decimal degrees) and elevation (in meters or feet). The GPS is

integrated into the deployable unit's configuration program. It has a minimum accuracy of 100 feet (30 m) under normal conditions without selective availability.

- The weather station consists of an integrated sensor module (exterior component) and a console (interior component). The integrated sensor module contains the interface module to support the console, rain collector, and anemometer. The integrated sensor module and console measures the following parameters:

    - Barometric pressure
    - Inside humidity
    - Outside humidity
    - Dew point (calculated)
    - Rainfall amount
    - Rain storm amount
    - Rain rate
    - Inside temperature
    - Outside temperature
    - Heat index (calculated)
    - Wind chill (calculated)
    - Wind direction
    - Wind speed
    - Direction of peak wind speed

  The console is mounted so the user can view all data when the compartment door of the main compartment housing is opened. The weather station is integrated into the configuration program that stores and captures the real-time data from the integrated sensor module and console of the following parameters:

    - Barometric pressure
    - Outside humidity
    - Rainfall amount
    - Outside temperature
    - Wind direction
    - Wind speed

- The platform also serves as a shipping pallet. Not only can all the components attach to it using thumbscrews, but the component shipping containers can be placed on it and secured for transportation. The components are stored and transported in containers, and each container includes a diagram and parts list on the inner lid.

4.2 Differences Between Fixed and Deployable Equipment

The equipment for the fixed and the deployable air monitors are different from each other for several reasons. Conceptual design for the deployable monitors began before 9/11 in response to needs identified in responding to the Hanford and Los Alamos fires. Due to the sense of urgency to improve readiness and the higher level of confidence in the deployable monitors, actions were taken to procure them in parallel with further development of the concepts for designing fixed monitoring equipment with real-time measurement capability.

There are also practical reasons for differences between the fixed and deployable air monitors. Because they are permanently installed, the fixed stations can be equipped with instrumentation that may be more susceptible to damage during transit, and thus may have a higher probability of needing service after shipping. Additionally, there are more options for data telemetry in large metropolitan areas, particularly when there are no time constraints on preparing for the installation. The deployable monitors must use equipment that has a low probability of failure from the handling that occurs during packing, shipping, and unpacking. They must also be capable of transmitting data from small cities or rural towns, with little or no time for pre-arranging telecommunications services.

4.3 Mobilization, Setup, and Demobilization of Deployable Monitors

Twenty deployable units will be stored at NAREL and twenty units will be stored at R&IE. The units will be stored in a ready-to-ship configuration with five units rotating out each month for testing, calibration, and quality assurance.

Mobilization personnel will be recruited from EPA’s Response Support Corps (RSC) in the affected region(s) immediately after the decision is made to use the deployables. Volunteers recruited from the RSC will help transport and set up the units in the event of a radiological emergency.

These personnel are expected to have an EPA government travel credit card, be willing to travel for two weeks or more, be capable of lifting up to 50 lbs. (22.7 kg), and have basic computer skills. Mobilization personnel are expected to make travel arrangements and arrive at the forward staging location (to be determined by the deployable leads) as soon as 24 hours post-incident. They will support the deployment efforts by setting up stations in teams of two, and collecting air samples as directed.

Efforts to recruit standing volunteers will be conducted, but since the deployables were designed to be set up and operated by people with no specific experience or radiation knowledge, volunteers can be called upon after an incident happens. This prevents the deployables from being an added strain on already committed radiation emergency response personnel who will be very busy during the aftermath of a large radiation incident.

Recruitment/regular training: New volunteer introduction will be presented each year at the many national EPA meetings. Refresher courses will be offered electronically, utilizing the set-up video on a website. Volunteers will receive a new certificate of accomplishment / appreciation each year. Training will be supplemented with frequent hands-on exercises to give the mobilization personnel experience with deploying the monitors.

Call down list: Regular drills will be conducted by the two full-time deployable leads to verify phone contacts. Mobilization personnel will have to provide 24 hour contact information through the RSC.

Response Support Corps activation: Requesting activation of mobilization personnel from the RSC varies slightly between EPA regions but is overseen by the National Incident Coordination Team (NICT) in which ORIA is an active participant.

Radiation exposure considerations are minimal for mobilization personnel because deployables are intended to be used at a distance of 30 miles (50 km) or more from the site of an incident (outside the affected area).

In the event of a radiation incident or perceived emergency, the deployables will be shipped to a previously selected operator at a location near the event as directed by the command and control portion of the organization. The deployables will be shipped with each component or group of components in cutout foam lined shipping cases with the mounting pallets stacked and shipped as a group. The portable electric generators and calibrators will be shipped in their individual shipping containers if needed.

The person selected to operate the deployables shall meet minimum qualifications described previously, but need not have experience or training in the operation of the system. That person would be asked to assemble the components and initiate monitoring and sample collection. Operator manuals, written instructions, and video tools will be provided to assure proper setup and operation of the systems.

If possible, the system will be assembled and operated at a public facility, such as a fire or police station, or other public office/facility to allow for easy and unrestricted access to line power for the system operation. Selection of, and agreements with the chosen facility will be negotiated or established by the deployables team lead(s), who will also oversee the mobilization personnel activities. Second choices for sampling sites would be privately owned locations. If a location offering line power is not available, a generator will be used to supply power, and will be maintained/fueled by the operator.

Detailed setup and calibration verification instructions exist on video and also on a laminated text version attached to the unit. It takes about an hour to set up one unit. Sample (air filter) collection during incident response will be done by mobilization personnel. Frequency of sample collection may vary between hours and days, as determined by the data goals and practical considerations.

Disassembly and repacking for return to the labs will be conducted by the mobilization personnel. Transport of the units back to the labs can be accomplished by a less expensive mode (e.g., commercial freight) by some of the same personnel.

4.4 Siting the Deployables

Orders to deploy generally will come from ORIA managers upon the recommendation of the RERT commander or in response to a request from other Agency officials or other federal/state officials. Although several different ways are available to transport the deployable monitors to the vicinity of an incident, the chosen options depend on urgency and the funding source. Flexibility is needed to respond appropriately to unique or dynamic situations.

In general, shorter transit time will cost more. If shipping commercially (FedEx, Consolidated Freightways), the Deployable Team Leads and laboratory staff will load and ship the units, and the mobilization personnel will receive and set them up. If using dedicated vehicles, then mobilization personnel will load, drive, unload, and set up the units. If using military air transport via a pre-arranged agreement, then the Deployable Team Leads and laboratory staff will prepare the units and transfer them to military vehicles. Mobilization personnel will receive and set them up.

The layout of the deployables depends on a number of factors, including the incident scenario, data goals, meteorological conditions and population density. Once the RERT commander and ORIA management agree that deployables should be used, dose assessment and modeling tools will be used to place the monitors most strategically to support the mission. There are two very broad categories of radiological incidents in which the deployables would be useful:

- A radiation release from a foreign source with no specific site, where radiation may impact very large areas of the country
- A radiation release creating one or more sites around which the deployables could be set up to monitor the perimeter

Under the first scenario, deployables complement the fixed RadNet stations by increasing coverage near affected areas after an incident. Fig. 4.1 shows the projected placement of the 180 fixed stations. Deployable units may be placed to maximize RadNet's coverage in response incidents with nationwide impacts.

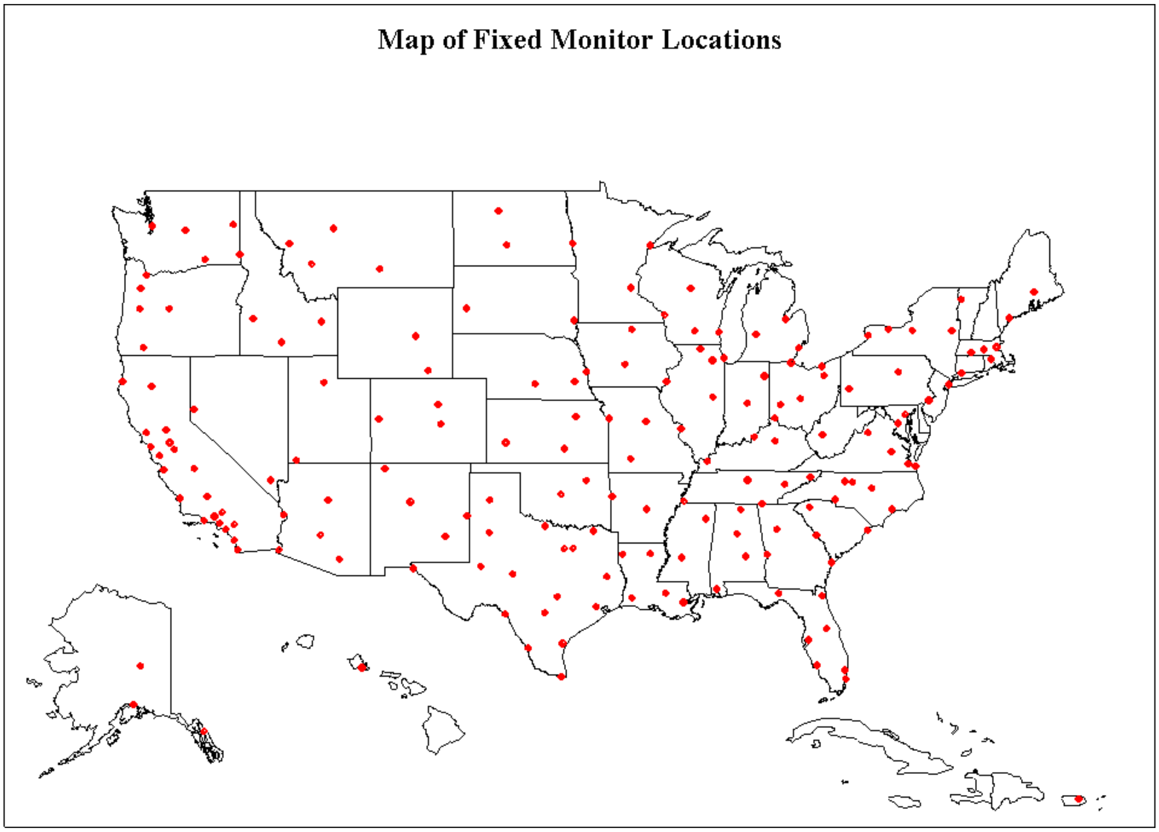
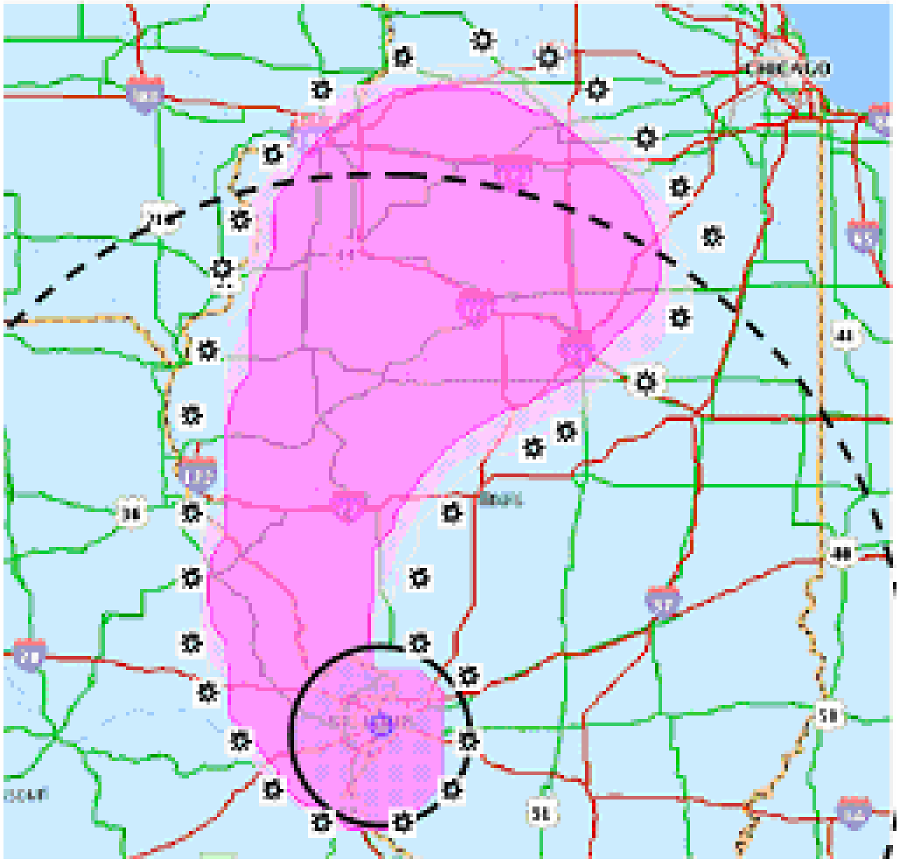


Fig. 4.1. Fixed monitor stations.

Under the second scenario, deployables complement the fixed RadNet stations by monitoring the perimeter of a radiation incident site and adding greatly to the amount of data collected by RadNet for the incident. Fig. 4.2 shows the general concept of placing the deployables around an incident site, primarily to ensure that areas presumed to be safe for the public *continue* to be safe.



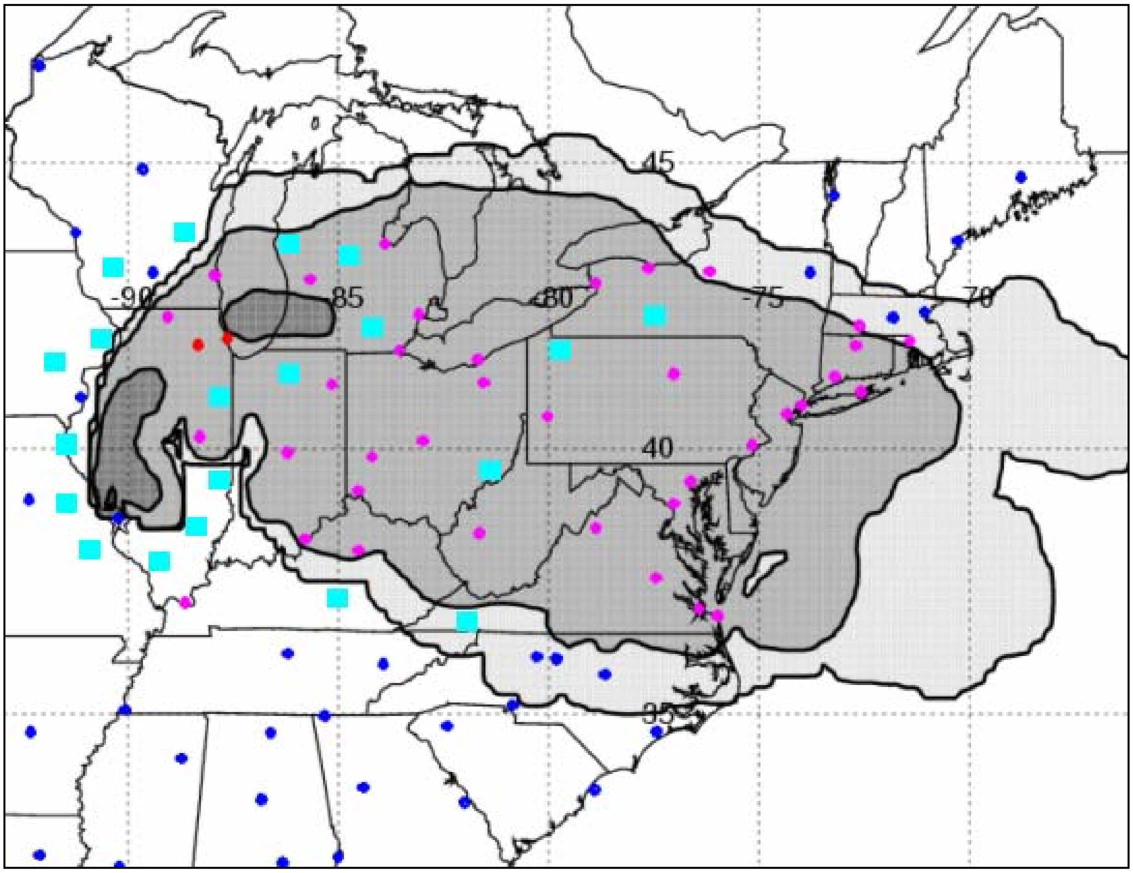
10-mile radius around incident location

50-mile radius around incident location

Deployable monitor

Fig. 4.2. Schematic of deployable monitors surrounding a site.

A third possibility is to use the deployables in a combination of both of the layout schemes described above. Fig. 4.3 shows how some units might be around the incident site perimeter with others in between the fixed units to increase coverage.



■ Fixed stations detecting contamination
■ Fixed stations detecting contamination in lab analysis of air samples
■ Fixed stations not detecting contamination
■ Deployable stations

Fig. 4.3. Example of deployable monitors in conjunction with fixed monitors.

The deployable units can be moved around to suit the changing incident conditions and data needs. This capability adds greatly to the flexibility and usefulness of the system as a whole.

5 DATA

5.1 Generated

5.1.1 Fixed Monitoring Stations

5.1.1.1 During Routine Operations

Real-Time

Data generated and stored locally in the fixed monitoring stations are integrated over two separate user-programmable intervals. The longer of the two is the sample collection interval, or segment of time between filter changes. The shorter is the radiation data acquisition interval, which is currently anticipated to be about one hour but can be programmed to intervals as short as 10 minutes. A data record, generated and stored at the end of each of these intervals, will include the following:

- Date and time that acquisition began and ended
- Real time and live time for data acquisition in seconds
- Beta count rate
- Count rate for each gamma region of interest (ROI)
- Total volume of air that has passed through the filter since the last filter change
- Complete gamma spectrum file
- Ambient air temperature and pressure and the optional wind speed and direction if so equipped, averaged over the data acquisition interval

In addition, the following data will be stored for the current and at least the most recent two sample collection intervals:

- Date and time that the sample collection began (and ended, if applicable)
- Total sample volume (corrected to STP) collected (or collected thus far, if sampling is in progress)
- Average, minimum, and maximum sample flow rate (corrected to STP)
- Total number and duration of any power interruptions lasting more than one minute

A new radiation data acquisition interval is automatically initiated every time a new sample acquisition begins, and any in-progress radiation data acquisition interval automatically terminates when the air sampler is stopped. This ensures that radiation data acquisition intervals always can be correlated with the integrated sample volume.

All the records except the complete gamma-ray spectrum are automatically transmitted to the primary data repository (NAREL) at user-programmable intervals. The gamma-ray spectra are normally stored locally in the monitoring station only, and are retained only for a few weeks.

Field Measurements and Laboratory Analyses

At least five hours after each filter change (to allow time for decay of radon progeny), the fixed monitoring station operator will count the filter for gross alpha and beta radioactivity and calculate the corresponding concentrations in air. An action level will be established that, if exceeded, will signal to the operator to notify EPA staff and ship the filter media by more expeditious means. Otherwise, the filters will be sent to NAREL by first class mail for analysis.

Fixed monitoring station filters received at NAREL will first be logged into the Laboratory Information Management System (LIMS). Data entered will include the results of the gross alpha and beta counts performed by the station operator and the volume of air that has passed through the filter. Filters will then be counted again for gross alpha and beta radioactivity. If the resultant air concentration exceeds predefined action levels, then additional analyses as described in Section 5.1.1.2 will be performed to investigate. The laboratory gross alpha and beta counts, and each additional analysis performed, will be stored in the LIMS.

The other routine laboratory data generated is from isotopic uranium and plutonium analysis on a composite of all filters collected at each site during each calendar year.

5.1.1.2 When Elevated Radioactivity Levels are Detected or Anticipated

If the near-real-time gamma ROI or gross beta count rate data are higher than expected or increase suddenly, NAREL staff will remotely connect with one or more monitoring stations to initiate transfer of the full gamma spectrum file, then perform a quantitative gamma spectrometric analysis to determine the isotopic concentration in air. The concentrations in air calculated by this method will then be stored in the NAREL LIMS. Upload and analysis of the gamma spectra files may also be done without waiting for detection of unusual readings, based on other indications that a radiological incident has occurred or is anticipated.

Depending on circumstances, NAREL may also perform any or all of the following laboratory analyses on individual air filters:

- high-resolution gamma-ray spectrometry (high-purity germanium)
- Pu-238 and Pu-239 (alpha-particle spectrometry)
- U-234, U-235, U-238 (alpha-particle spectrometry)
- Am-241 (alpha-particle spectrometry)
- Th-227, Th-228, Th-230, Th-232 (alpha-particle spectrometry)
- Sr-89 and Sr-90 (gas proportional counting)

- Ra-226 (alpha scintillation counting)
- Ra-228 (gas proportional counting)

The analytical methods used at NAREL are documented in the *NAREL Radiochemistry Procedures Manual* (EPA02).

Counting times for most analyses can be adjusted to achieve a range of detection and quantification capabilities. All Ra-226 analyses involve 1000-minute count times. Most routine analyses by gamma-ray spectrometry or alpha-particle spectrometry involve 1000-minute count times. In an emergency these count times may be reduced to improve turnaround times, or when necessary, samples may be counted for longer intervals, up to several days, to improve the counting statistics. The other listed analyses typically involve 100-minute count times. Appendix H contains a list of nominal detection limits for radiochemical analyses conducted at NAREL.

Turnaround times for gamma-ray spectrometry, alpha-particle spectrometry, and liquid scintillation counting may be as short as one or two days in an emergency. Strontium-90 analysis requires more time, because a delay of several days is needed to allow the decay product Y-90 to build up before counting begins. Ra-226 analysis is time-consuming and may require weeks, depending on the required detection limit.

5.1.2 Deployable Monitoring Stations

In general, these monitors are only expected to be deployed in response to a radiological incident or emergency. However, they may occasionally be pre-deployed to provide monitoring capability at a location where there is no operable fixed monitoring station. Thus, rather than having distinguishable routine and incident response modes of operation, they will be simply operating or not operating.

When operating, the real-time data generated by and stored in the deployable monitoring stations are integrated over user-programmable intervals. For each interval, the data stored include:

- Local date and time that the data record was stored
- For both the high-volume and low-volume air samplers (separate data records for each), the average flow rate, integrated sample volume, filter differential pressure, and air inlet temperature and barometric pressure
- Gamma exposure rate (both channels separately as well as the mean)
- Latitude and longitude
- Weather station parameters, including barometric pressure, outside humidity, rainfall amount, outside temperature, wind direction, and wind speed

The analysis to be performed on filter media from the deployable monitoring stations is not pre-defined, rather, it will be determined based on known or suspected radiological contaminants specific to the reason for which the monitor was deployed. Laboratory analyses that can be performed on the filter media for the high-volume sampler are the same as those for the fixed monitoring stations. In addition, the low-volume sampler can utilize specialized media for collecting iodine or tritium. These samples would also be sent to a fixed laboratory for analysis. Instrumentation for initial counting of sample media by the operator, prior to sending the samples to a laboratory, is not integral to the deployable monitors, but could be performed if the necessary instruments are available to the operator.

NAREL may perform any of the laboratory analyses listed in Section 5.1.1.2. It may also analyze the samples for:

I-131 (gas proportional counting)
H-3 (liquid scintillation counting)

Routine count times for I-131 are 1000 min. Count times for H-3 are typically 100 min.

The analytical procedure used for I-131 is intended for low activity levels. At higher levels, high-resolution gamma-ray spectrometry may be employed

5.2 Real-Time Data Transmission

5.2.1 Fixed Monitoring Stations

Each time a data acquisition interval for the radiation detector ends, the total accumulated counts in each gamma region of interest and the beta channel will be transmitted to NAREL, automatically or on demand, via redundant communications systems that are integral to the monitoring station.

Incoming gamma ROI and gross-beta count-rate data will be screened by computer for high level and high rate of change compared with previous measurements. If an abnormal condition is detected by this screening, the computer will notify NAREL staff. As necessary, NAREL will connect remotely with a monitoring station to initiate transfer of the full gamma-spectrum file and perform a quantitative gamma spectrometric analysis to determine the isotopic concentration in air.

5.2.2 Deployable Monitors

Data collected by the monitoring system will be transmitted to NAREL automatically or upon demand by the system data logger through the Iridium satellite network or telephone modem. Data also will be downloaded by the system operator to the PDA for storage and potential transfer to other organizations as required.

5.3 Data Storage

The RadNet data repository will hold the near-real-time air monitoring data from the fixed and deployable monitors, data obtained by laboratory analysis of air filters collected from the same monitoring stations and all laboratory analysis for the remaining non-real time components of RadNet (old ERAMS). All data developed in support of RadNet will be collected and analyzed at NAREL, and the results of these analyses will be stored within the lab information management system. The telemetry data will indicate which station is providing the feed by the use of a unique identifier to associate the data to a specific site.

5.4 Data Review

Data from both the fixed and deployable monitoring stations consists of near-real-time data and data from analysis of the filters after removal from the monitors. The near-real-time radiation data from the deployable monitors is ambient gamma exposure rate. For the fixed monitors, the near-real-time radiation data is filter medium beta count rate and gamma count rate in 10 Regions of Interest. Both the fixed and deployable monitors also transmit air sampler data (such as volumetric flow rate and total volume sampled) and meteorological parameters (such as wind speed and direction, ambient temperature, and barometric pressure).

5.4.1 Real-Time Data (See Section 6.7)

5.4.2 Analytical Data

All analytical data generated at NAREL will be reviewed as required by the *NAREL Radiochemistry Quality Assurance Manual* (EPA03c) and the NAREL *SOP for the Review of Radiochemistry Data* (EPA03b). These documents require two independent formal reviews of each analysis. The first review occurs at the time the sample results are computed, is typically done by the analyst, and is done before analytical results are stored in final form within the repository. The second review is performed by an *independent* individual.

If a RadNet sample contains an unexpected radionuclide, an unusually high level of gross alpha or beta radiation, or a high concentration of any analyte, the data reviewer completes an event report that is routed to laboratory management and quality assurance personnel. Two independent reviews of the individual analytical results and the data reports are reviewed and signed by NAREL's Quality Assurance Coordinator, and the Monitoring and Analytical Services (MASB) chief.

5.5 Data Dissemination

During emergency operations, the timely sharing of data is crucial. EPA is proposing a structure and process to provide access to the RadNet data on a routine basis that will be in place to also provide data access during emergency operations.

5.5.1 Access to Data by Recipient Groups

The proposed data access model is designed to provide appropriate access and information to ensure our stakeholders receive RadNet data in a timely manner during emergency operations. As quickly as possible, access will be provided to three groups of people: an immediate access group; an intermediate access group; and the general public. The access level for the immediate and intermediate groups will be granted by the ORIA Office Director or designee, and set up upon request by NAREL and OEI.

5.5.1.1 Immediate Access Group

Specific radiation professionals including EPA Regional Radiation Representatives, FRMAC, and others(upon request), will be provided immediate, anytime access to all of the RadNet data, including raw data, validated data, and historical data. This data may include unconfirmed or erroneous elevated readings. Access will be provided on the EPA website through a secure login, password, and token.

5.5.1.2 Intermediate Access Group

Once the data has undergone an initial review it will be made available with appropriate context (if needed) for a broader governmental audience, including State Emergency Operations Centers (EOCs), other federal agencies, states, locals and tribes, and others upon request. It is anticipated that the initial review process will require several hours for air monitoring data in emergency situations. Access will again be provided on the EPA website through a secure login, password, and token.

5.5.1.3 General public

After completion of the normal review, the general public will have internet access to the final data set, including both near-real-time data and results of the filter analyses. Access will be through the EPA website.

5.5.2 Data Dissemination by System Status

5.5.2.1 Routine Operations

Data collected, transferred, stored, or shared during routine operations follow a procedure that is documented in the Quality Assurance Project Plan (QAPP). It is anticipated that all three groups will have access to the near-real-time data within hours of its transmission to NAREL.

5.5.2.2 When Unforeseen Elevated Readings Occur

RadNet has the capability to provide data continuously from both deployable (if operating) and fixed air monitoring stations. Routinely, the near-real-time data will be transmitted hourly, and can be transmitted more frequently during emergency operations. Once the data is received at the secure server at NAREL it will be made available to the immediate access group. The data will undergo an initial electronic data review, comparing the incoming data to trigger levels for each station, as well as the rate of change. If an anomaly is identified, NAREL scientists will conduct further review and analysis to determine if the reading can be confirmed (see Section 6.7). The data will then become available to the intermediate access group. If the reading appears to be credible, the RadNet duty officer will notify the NAREL management, who may request implementation of notifications and an increase in sampling frequency.

There are many circumstances in which we expect false anomalous readings from the real-time monitors. Data review will require several hours, and appropriate groups will be notified in the event that a reading is confirmed. If requested, appropriate groups can be notified every time an anomalous reading is identified in a given state or location, before the review process is begun. Absent the activities of the FRMAC or the designation of a coordinating agency, it is anticipated that the data will be available to the public within 24 hours after it has completed the normal review process. If the FRMAC is activated, data will begin to flow through the FRMAC.

5.5.2.3 During a Known Radiological Emergency

EPA will share data in compliance with existing Federal policies and procedures (see Sections 2.2 and 2.4).

The FRMAC provides an operational framework for coordinating all Federal offsite radiological monitoring and assessment activities during a response to a radiological emergency. The FRMAC will support the coordinating agency, maintain a common set of all off-site radiological monitoring data, and provide monitoring data and data interpretation. During emergency operations, RadNet data would be provided to the coordinating agency through the FRMAC. If authorized by the FRMAC or the coordinating agency, data access will continue to be available to EPA's regular "customers."

5.6 Data Security

Security of the data flow from fixed or deployable monitoring sites will not follow the same path as other RadNet components. The data flow for the remaining components (precipitation, drinking water, and milk) is not reflected in this section. They are covered by the RadNet IT Security Plan (EPA05b). Telemetry from the monitoring sites to the data repository will be through secure encrypted communication modes as outlined in the RadNet IT Security Plan. Information security is based on Federal Information Processing Standards 199 (NIS04) and National Institute of Standards and Technology requirements (NIS98, NIS01, NIS05).

5.6.1 Data Flow

Once stored in the data repository, the data will be made available to the different users in near-real-time (Fig. 5.3). The data routing steps are as follows:

1. Information is collected by the fixed or deployable collector (monitoring station).

2. The collector compiles the data file for transfer.

3. The data are transferred from the fixed collector to the primary file server using one of three possible media (deployable has two media).

4. The data file on the file server will be processed by the parsing software. The following parsing is performed on the data:

   - Check for integrity
   - Check for out of normal readings
   - Profile against specified business rules

5. Based on the results of the parsing, automation software will complete the following actions:
   - If an error occurs,
     - provide notification of the error to an on-call NAREL representative, or
     - hold the data until disposition is determined by a NAREL representative.
   - If error-free, prepare data for final processing.
   - Input into final form within database.

6. NAREL will process the collected data. (Processing the data involves review and approval by the authorizing agent.)

7. Approved results will then be input.

8. Data will then be available for viewing via the Internet or according to established access controls.

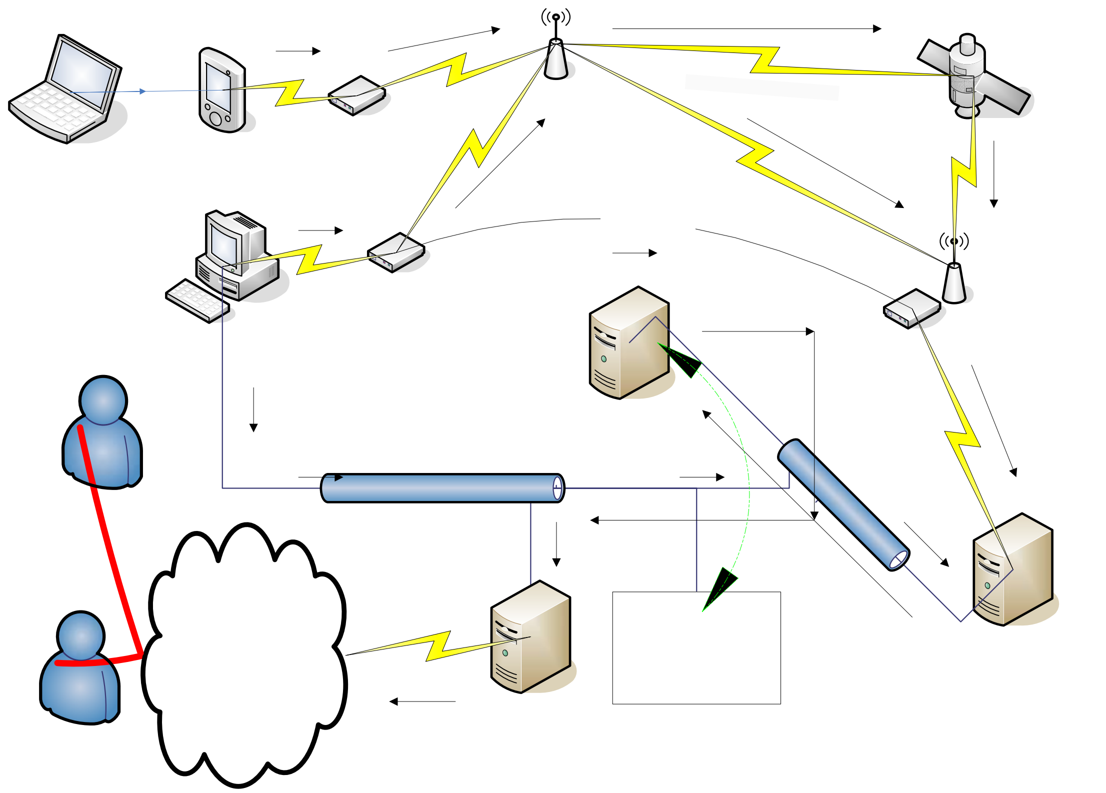


Fig. 5.3. Routine data flow.

5.6.2 Access

The RadNet IT network will connect to a web portal (to be determined) to provide external access to information contained in the database, the Internet, and commercial database services. Access and administration of local network resources are restricted to authorized users only. Authorized users will meet all requirements of the EPA and NAREL's security awareness program before a local account is activated.

Internet access is still being determined due to FIPS 199 requirements. A link will be established between the repositories and their locations. User access will be granted on a need and type basis. Who specifically is to have access to the different types of data is still being determined. The type of data that will be accessible will be defined later. Data may include those from all existing RadNet monitoring methods (air particulates, precipitation, drinking water, and milk). Templates will be used for visual representation of the data.

There are two groups of RadNet resource users. The first group consists of those who use the hardware and handle the data directly, and the other group has read-only capabilities.

Data handlers will be kept informed of system rules through annual awareness training and local security rules of behavior. As the need arises, notification and instructions are disseminated on how to deal with (or avoid) system viruses, trojan horses, denial-of-service attacks, and terrorist threat levels. Communication reminders of relevant rules of behavior can aid in reducing system vulnerabilities that are introduced typically by uninformed or misinformed users. These reminders will be sent through the EPA enterprise network because RadNet has no e-mail capability.

The users who have read-only rights will have very restrictive controls placed on them based on the different views of the data that are available. The data sharing levels of access are still being defined.

5.6.3 Physical security

5.6.3.1 Monitoring stations (as specified in the siting criteria in Section 3.6)

5.6.3.2 NAREL network

- Physical Access Controls

  - Theft, vandalism, and unintentional damage. All server systems are located in rooms with key locks/combination locks. Only System Managers, the Information Security Officer (ISO), and building facilities personnel have keys and combinations. Access beyond the lobby area of the building is restricted by security guards and employee identification badges. The monitors that feed information to the RadNet data repository are housed in a case that is controlled by lock and key. Per the monitor siting criteria, physical security was considered prior to placement and activation of the monitor.

- Environmental Controls

  - Fire Damage. Fire prevention measures include an automatic fire suppression system, hand held extinguishers, and alarm systems. These controls are outside the responsibility of NAREL network management. They are maintained and tested by the building's facilities personnel.
  - Water Damage. Local Area Network (LAN) equipment is susceptible to damage from water leaks from overhead pipes and water from fire fighting and/or leaks on floors above the servers. While NAREL recognizes this threat, it has been determined that the only cost-effective controls are the use of plastic sheeting to protect equipment from overhead leaks. Users are also instructed to provide proper storage of media (disks, diskettes, and documents) to protect against damage from moisture as well as extreme heat or cold.
  - Electrical Outages and Fluctuations. NAREL has installed an uninterruptible power supply (UPS) system to counter this threat. The building also has a generator backup to minimize impacts from short-term power outages.

5.6.4 Hardware and Software Protection

RadNet will have the following hardware and software maintenance controls in place to ensure that the software functions correctly and is protected from corruption.

- Only authorized individuals have access to software media.
- All software is inspected and tested in a controlled environment prior to installation on servers.
- Software licensing will be maintained by NAREL, and any software provided by the Washington Information Center (WIC) will be site-licensed for the Agency.
- All original software and backup copies are stored in the NAREL media library. Only authorized individuals have access to the media library.

The ISO and System Administrators have access to network monitoring and auditing applications. These applications give the ISO and System Administrators tools to identify, monitor and correct unauthorized or unacceptable activities on the system.

5.6.5 Configuration Management Controls

Configuration management controls are enforced through the use of NAREL/RadNet Access/Request for Assistance Form using the NAREL TRACK-IT system. NAREL configuration management controls will ensure that software versions and releases are tracked and all changes to the RadNet hardware and software (including network changes and connections) are authorized, inspected, and tested. This configuration management process will also include the verification that all associated system documentation is reviewed and updated, if required.

5.6.6 Personnel Controls

RadNet information is managed by the NAREL ISO and is currently operated and maintained by contractor support staff. The ISO/LAN Manager is the Project Officer for the on-site contractors. The contractors routinely configure, monitor, and administer the daily operations of and access to stored RadNet data.

Microsoft Active Directory and LIMS login authentication processes are security features to determine each user’s system access level(s), as well as rights to directories, files, and programs/applications residing on the system. The level of access is determined by the ISO/System Administrator in conjunction with the supervisor/manager and submitted as a LAN Access Request Form to the ISO/LAN Manager for approval and processing by the system administrators.

Prior to account activation, new users are required to provide written certification that they have read and understood the network security points of contact and rules of behavior, including incident reporting procedures, password management, and virus protection directives. In addition, new users are required to have completed all the information security awareness training. Refresher security awareness training provided by EPA's Office of Environmental Information (OEI) is required on an annual basis.

Security duties are distributed among various personnel to ensure that no single person has all authority or information access, which could result in fraudulent activity or intentional destruction of data.

RadNet data users are granted the least privilege required to accomplish their administrative and workstation support duties. Direct access is granted on a case-by-case basis, but generally is limited to NAREL employees and their contractor staff, students, interns, and detailees. Position sensitivity levels for federal personnel are established by EPA's Human Resources Management Office.

Personnel screening and background checks for on-site contractors are covered under the EPA's contract guidelines. Positive identification is required for all users of RadNet resources.

5.6.7 Audit Trail Mechanisms

Network systems will be configured according to EPA standards to provide adequate safeguards to protect the network without creating undue intrusions on user privacy. Access controls are built into the system to prevent unauthorized use. A user is denied access after three unsuccessful attempts to log on. If, as a result of the risk assessment, additional mechanisms beyond those available under Microsoft operating systems are deemed necessary, auditing software will be acquired and implemented on the network. Security management and monitoring software will provide for identifying and reporting information technology security policies conformity and any violations.

5.6.8 User Identification and Authentication

User identification and authentication controls have been configured as follows:

- Use of the system is permitted only upon presentation of a valid user identifier and authenticator (user-ID and password).
- All NAREL personnel provided with a user-ID and initial password are trained and notified of their responsibilities with regard to the use and protection of their access privileges.
- Passwords must meet existing EPA requirements.

5.6.9 Authorization/Access Controls

Authorization and access controls for the network include the following:

- A process has been established to authorize access to network resources. Site coordinators must submit a form to the NAREL System Manager authorizing access, based on position, to specific network resources. The RadNet network limits access to authorized persons only and ensures that they can reach only those resources for which they have authorization. Individuals may be authorized for additional access based on their particular skills and responsibilities.

- The user's need for access is reviewed periodically to ensure that only authorized users have access.

- Access to network administration functions are limited to the fewest number of network management staff possible. These restricted functions include access to operating systems and utilities, network management software, security software, and database administration utilities. In addition, records of all accesses to these functions are maintained in the system audit trail.

- Access privileges to network resources will be revoked for users who intentionally violate security policies.

- Access authorization is suspended in response to three repeated incorrect submissions of a user identifier and password. The user must request reactivation from the system administrator.

5.6.10 Integrity Controls

Standard EPA virus protection utilities, as detailed in the *LAN Operational Procedures and Standards Manual* (EPA05a), are used to identify and eliminate viruses. Current updates are maintained and distributed by EPA. File servers scan all incoming files copied to the server disk drives. Elimination of viruses is performed by the NAREL system administrators.

The BindView and Enterprise Security Management (ESM) software are designed to manage and enforce security data and policies across a full range of client/server platforms to include Microsoft Server 2003. EPA determines which policies and procedures need to be established to ensure restricted access to secured systems and resources. BindView and ESM check compliance with these procedures and make recommendations regarding potential breaches in security.

Full-system backups are performed weekly and differential backups are performed nightly. This schedule ensures that no more than one day's worth of data would be lost. The backup tapes are regularly stored at an offsite location.

6 QUALITY ASSURANCE AND QUALITY CONTROL

6.1 General Quality System Requirements

In order to ensure that RadNet data are accurate, reproducible, of known and desired quality, and suitable for their intended use, EPA requires that a formal, documented, and monitored system of quality assurance (QA) and quality control (QC) activities be in place. This Quality System (QS) must address all aspects of RadNet as it functions in both routine and emergency situations. The Quality System must include requirements and guidance for all aspects of the RadNet operation, including—but not limited to—training of sample collectors; calibration, operation, and maintenance of field and laboratory equipment; physical sample collection, handling, shipping, tracking, and receipt; analysis and evaluation of transmitted data; physical sample screening, preparation, analysis, documentation, reporting, and evaluation; and data sharing and dissemination. For the purposes of this document and the SAB review, discussion of QA and QC will be limited to the fixed and deployable air monitoring systems.

EPA Order 5360.1 A2 states:

> "A consistent, Agency-wide Quality System will provide, when implemented, the needed management and technical practices to assure that environmental data used to support Agency decisions are of adequate quality and usability for their intended purpose." (EPA00a)

In addition, Section 2.1 of QA/R5 requires:

> "All work funded by EPA that involves the acquisition of environmental data generated from direct measurement activities, collected from other sources, or compiled from computerized databases and information systems shall be implemented in accordance with an approved Quality Assurance Project Plan (QAPP) (EPA01). The QAPP will be developed using a systematic planning process based on the graded approach. No work covered by this requirement shall be implemented without an approved QA Project Plan available prior to the start of the work except under circumstances requiring immediate action to protect human health and the environment or operations conducted under police powers."

EPA and NAREL policies for RadNet and other programs require adherence to QA procedures established by Agency mandates, EPA Quality Staff directives, and established and recognized good laboratory practices at all times. These directives apply to a fixed laboratory, such as NAREL, sample collection in the field, samples prepared and analyzed in a mobile laboratory, and fixed and deployable data-collecting units. Such adherence requires that at a minimum--

- facilities are adequate for the work to be performed and are maintained and monitored to prevent adverse impact on data quality;
- equipment and facilities included in a mobile, off-site, or deployable data-collecting unit are maintained and monitored to prevent adverse impact on data quality;
- reagent purity is assured by selective acquisition and internal checks;
- technicians, professional bench scientists, project officers, and line managers are well qualified and trained in laboratory and field methodology in their areas of responsibility;
- personnel qualifications and training are fully documented;
- field and analytical activities for RadNet are governed by formal policies mandated in the NAREL's Quality Management Plan, the RadNet Quality Assurance Manual (QAM), and a number of applicable Standard Operating Procedures (SOPs); and
- periodic audits and inspections are conducted of facilities, programs, and operations that provide samples or environmental data.

These tasks and activities serve as a base for continuous monitoring of the processes and results of the system, assuring acceptable quality and usefulness of the data produced. The Quality System must ensure that NAREL staff continuously assess the capabilities of analytical methods to meet the required data quality objectives (DQOs), monitor the routine operational performance of laboratory instruments and equipment through appropriate equipment checks, perform audits of standard samples for evaluation of laboratory performance, and perform corrective actions as necessary.

6.2 Evaluation of the RadNet Quality System

In the assessment of the current and historical RadNet system and the expansion of the air network, it became obvious that while ERAMS/RadNet has strengths that can be expanded, there are also critical tasks and activities that need to be improved, expanded, or implemented. These include improved documentation for the system, improved training for station operators, addition of quality control samples when analyzing RadNet samples in the laboratory, inclusion of quality assurance data and information in the Environmental Radiation Data reports (ERDs), plans for evaluating the RadNet, and a plan for preparedness exercises for emergency readiness.

In accordance with the EPA Science Policy Council's directive, in a formal policy for laboratory competency, NAREL will be seeking accreditation for much of its analytical program by NELAC standards. This will require revision of all documents related to the quality system over the next year. Practices required by NELAC 2003 will be incorporated as the quality system for RadNet is updated (EPA03a).

As part of the reassessment of QA and QC policies and procedures for RadNet, a team worked through EPA's recommended DQO (Data Quality Objectives) process (EPA00c), evaluating the entire process of collecting, receiving, and analysis of RadNet samples, and review and reporting of RadNet data, both transmitted near-real-time data and the filters collected by the fixed or deployable monitors (EPA00b). As a result of this exercise, decision points were recognized and the team made an effort to provide guidance for improvements in quality control and quality assurance of RadNet data, both the near real time data from air monitors and for the laboratory analyses of air filters received at the laboratory.

6.3 The Quality Assurance Project Plans for Routine and Emergency Operations

Reviews of the ERAMS QAPP, published in 1982, and the ERAMS Manual, published in 1988, were begun during the first consideration of reconfiguration of ERAMS in 1995 and 1996. ERAMS/RadNet is currently operating under a Quality Assurance Manual written in 2001. The QAM will be revised extensively to include the current expansion of the RadNet air monitoring capabilities and to meet requirements of the NELAC standard. The 1988 ERAMS Manual is still being used, but will be significantly revised as new equipment and procedures are put into place, new Standard Operating Procedures (SOP) are completed, and new training becomes available for station operators.

As the RadNet air network becomes ready for implementation, two new Quality Assurance Project Plans will be completed, one for the system of fixed air monitors and the second for the system of deployable monitors. The QAPPs will cover routine operations and outline acceptable practices for operation during an emergency situation. Guidelines to provide data quickly in a time of emergency, with adequate quality control, will be presented. Improvements in the new QAPP will reflect the goals and objectives of the expanded network, formally impose good laboratory and field practices for the system, update policies and procedures to current methods and equipment, and upgrade the entire QA and QC program for the system. It is likely that as other phases of the current RadNet network, e.g. milk and water sampling, are updated and upgraded, additional new QAPPs will be produced. The various QAPPs may be combined into an overall RadNet QAPP once all expansions and improvements are completed.

6.4 Standard Operating Procedures

6.4.1 Fixed and Mobile Laboratories

EPA and NAREL policy require that SOPs be written for all routine activities. SOPs contain specific details and procedures to ensure that data generated by their use will be of known and adequate quality. An SOP details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps.

SOPs for operation and deployment of the Mobile Emergency Response Laboratory (MERL) and analyses to be performed in the MERL will include SOPs for all routine sample handling in the mobile laboratory: sample receipt, login, tracking, screening, preparation, and analytical procedures; instrument calibration and use; handling and shipping samples to the fixed laboratory; and quality control, documentation, data review, and reporting.

6.4.2 Standard Operating Procedures for RadNet

Old versions of eight SOPs specific to ERAMS exist but most will be obsolete as new monitoring equipment is installed for RadNet. New SOPs will be written to reflect the objectives of the system and the particular methods and equipment to be used. These SOPs will include field sampling activities; training of station operators; sample handling and screening in the field; sample preparation, treatment, and shipping; instrument calibration, maintenance, and operations; data validation and anomaly identification; sample tracking; and internal quality control, and quality assessment of data collected, in both routine and emergency situations.

6.4.3 Standard Operating Procedures for the Fixed and Deployable Data Collection Units

SOPs also will be written for the fixed and deployable data collection units and will be provided to station operators as part of their training. The SOPs will be included in the document control system to ensure that revisions are distributed to all station operators in a timely manner. SOPs for the data collection units will include all steps for calibration, maintenance, and use of the units; procedures for screening filters in the field and shipping of filters to NAREL; reception of real time data at NAREL; evaluation of that data; and reporting and dissemination of the data.

6.5 Training and Quality Control Protocols for Station Operators

A major area to be emphasized in RadNet is the training of sample collectors and those who work with the fixed and deployable air monitors. The volunteer collectors who will operate the fixed monitors, while capable and experienced in their various fields, may not have access to specific training required of EPA personnel. To address this critical area, a professional and accurate training video is being produced. This is a cost-effective and efficient way to ensure consistency in the collection, handling, screening, documenting, and shipping of RadNet samples. SOPs and mentoring by NAREL and R&IENL staff will also provide training. As each fixed monitor is set up, the manufacturer will calibrate and test the monitor and will provide initial training to the operator of the monitor.

For the deployable monitors, operators from NAREL or R&IE will set up the monitors, make initial calibration checks and take background readings, and set up the instrument for transmission of data to NAREL at a fixed interval. A form is being developed so that as each unit is set up, pertinent information is documented and then sent by fax or e-mail to NAREL. All these steps for training EPA staff and the possible use of volunteers as operators will be documented in SOPs.

6.6 Instrument Calibration, Verification, and Maintenance

The manufacturer of the fixed monitors will, when a site is certified as prepared, deliver the monitor to the site, set the monitor up, perform any required initial performance checks, and work with the site operator for initial training. Once the manufacturer certifies the monitor as correctly installed and working properly, the monitor will begin transmitting near-real-time data to NAREL, most probably at hourly intervals. The operator will stop the monitor and change air filters twice a week during routine operations, install a clean filter, and re-start the monitor. After a 10-minute background count, the monitor will continue to transmit data to NAREL.

The current plan is that each monitor will be re-calibrated on an annual basis. Each operator will be sent a calibration kit which will include all information and transfer standards to calibrate the parameters of importance such as temperature, barometric pressure, and counting efficiencies of the monitor. Results of the re-calibration will be monitored from a remote site, most likely by a contracted service calibration technician.

Since NAREL has no real experience with the new model monitor, no preventive maintenance schedule has been set. Based on experience with other monitors, it is believed that the monitors will run steadily until a component fails, at which time the component will be replaced, the instrument re-calibrated if necessary, and the monitor will continue in service.

6.7 Assessment and Evaluation of Data Produced by RadNet

Policies will be developed and SOPs written as needed for assessment and evaluation of data produced by RadNet. While a data review process is already in place at NAREL for analytical data produced in the laboratory, additional planning is required for evaluation of data received from fixed and deployable data collectors and for more rapid review and evaluation of laboratory data during an emergency situation. In line with EPA's graded approach, it is important when evaluating RadNet data for dissemination to balance the need for rapid access to the data by decision makers against the need and requirement for data quality evaluation before certifying data as acceptable.

Under routine operating conditions, when there has been no alert or warning, the near real time data will stream into NAREL from each fixed monitor at approximately one-hour intervals. A series of automatic checks will be conducted by computer and if no problem is noted, the data will be archived for later review and inclusion in a RadNet report such as the ERD Reports currently produced for ERAMS data. During such routine operation, if the automatic check system is triggered by an out-of-bounds event, an alert will be sent to the designated reviewer, who will initiate hands-on review of the data.

In an emergency situation, the automatic checks will be in place, but a trained reviewer will be on hand to conduct an immediate review of all data. It is anticipated that this review of data could be accomplished in several hours.

In order to better understand the complexities of evaluating near real time data, EPA contractors from ICF Consulting surveyed other programs which conduct near-real-time environmental air monitoring, to learn what type of quality control processes can be used effectively for the RadNet near-real-time data collected. The final report is one of the sources of information for the planning process (ICF05c). A copy of the report is attached in Appendix I. The report contains information on five systems currently doing some type of near real time air monitoring, and evaluated several factors for each. These included the real time parameters being measured, available planning documents, how the monitors were installed and calibrated, instrument maintenance programs, training, data receipt and verification, QC limits, and how alerts and corrective actions are handled. Of the five systems only two are monitoring for radiation, one, Neighborhood Environmental Watch Network (NEWNET, run by DOE) for gamma and one, Community Environmental Monitoring Program (CEMP – run by DOE and Desert Research Institute) for both gamma and gross alpha-beta. Both systems use a tiered approach to data review and dissemination of the data.

Using the ICF report and other sources, a task group of the RadNet team is working through EPA's DQO (Data Quality Objectives) process in order to establish criteria for quality review of the near-real-time data and to provide warning limits to be applied to the automatic screening of data by software programs. Many of these trigger levels will be set initially based on best professional judgment and may be changed as NAREL staff gain experience using the new monitors.

For the fixed monitors, a number of channels of data are transmitted for each selected interval, usually one hour. These data include gamma and beta activity. For gamma activity, there are 10 regions of interest (ROI) which were pre-set during manufacture, but which can be re-set by NAREL once prototype testing is completed. NAREL will receive total gross activity and total net activity (gross minus background) for each of 10 Regions of Interest (ROI) for gamma radiation. The beta channel will include 5 ROIs. The beta detector specifications were optimized to respond to strontium activity.

For the deployables, similarly, an automated check will be used for near-real-time data, the default counting interval set at five minutes, and the data transmitted in uR/hour.

The fixed monitors will also transmit ambient temperature, ambient barometric pressure, wind speed and direction, sample flow rate, and sample volume at each interval. The deployable monitors are capable of transmitting latitude and longitude, rainfall, and flow rate and volume for both the high and low volume samplers.

Initial limits for triggering an alert by the computer data checking system have been set for the parameters of most concern and are discussed in the next section (Sec. 6.7.1). Once reviewed, anomalous data and data generated during emergencies will be evaluated by health physicists and/or dose assessors.

6.7.1 QC Limits

For initial automatic data checking of transmitted real-time data from the fixed monitors, it was decided to set trigger limits for parameters which might indicate monitor malfunction or shutdown or other possibly anomalies, and which might assist in evaluating the integrity of the transmitted data. Those parameters are: wind direction, wind speed, ambient temperature, ambient barometric pressure, flow rate, the K-40 ROI on the gamma detector, and the background reading from the beta detector.

6.7.1.1 Wind speed and direction

The trigger for wind direction is a wind direction outside a range of 0 to 360 degrees. Values outside the actual possible range of directions will indicate a problem with the instrumentation or software, and will trigger an alert for further review and investigation of the problem. The initial trigger for wind speed will be 39 miles per hour, the speed on the generally recognized Beaufort scale for the lightest gale force. If wind speed above 39 mph is indicated, NAREL will check with the site for true local weather conditions. If the value is incorrect, it will trigger an investigation into instrument problems. If the value is correct, the site operator may be asked to check the safety of the monitor in that and higher wind speeds and remove the mast or possibly the monitor until the high wind event has ended. As wind speed data are accumulated over time for each site, this trigger level may be adjusted. While wind speed and direction *per se* will be of little interest to data reviewers at NAREL, except for instrument integrity checks, they may be of interest to modelers and decision makers who receive and use the RadNet data.

6.7.1.2 Ambient Temperature

Trigger ranges for ambient temperature transmission will be site-specific based on historical data for daily and seasonal cycles obtained from NOAA’s National Climactic Data Center. Levels transmitted outside these ranges will trigger an alert for further investigation into possible instrument problems or real event weather anomalies.

6.7.1.3 Ambient Barometric Pressure

Ambient barometric pressure is site-specific within a relatively small range of change across the world, based primarily on elevation above sea level. For each site elevation, normal barometric pressure will be calculated. Trigger levels will be set at normal pressure ± 25.4 mm (1 inch) of mercury. Local barometric pressure rarely changes by more than this amount even in extreme conditions (GRE03). Transmitted values outside the site-specific range will trigger an alert for further investigation into possible instrument problems or other anomalies.

6.7.1.4 Flow Rate and Volume

The fixed monitor specifications call for a flow rate of 1m^3/minute ± 5%, resulting in an approximate air volume of 60 m^3 in an hour interval. If there is a power failure or for some other reason the blower on the monitor stops, the instrument sets the flow rate to 0. Initially, the flow rate and volume automatic triggers will be 57 – 63 m^3/hr, or 5% difference from the expected volume. Initially a flow rate of 0 will trigger an alarm to investigate further. With experience using the new monitors, this trigger level may be adjusted. Initially, a flow rate of 0 will trigger an alert for further investigation.

6.7.1.5 Gamma Activity

The gamma detector will transmit data, gross and net activity in each of 10 ROIs each interval. One ROI will be set to detect activity in the K-40 range as a monitor of consistency. Generally K-40 is found almost everywhere in soil and at constant levels for a particular location. In addition, the K-40 ROI should not be affected by activity from any radon or progeny. Over time, NAREL will trend gross gamma counts in the K-40 ROI for consistency. Counts outside a calculated range for each site will trigger an alert for investigation. Two possible detector problems can be indicated by a change in K-40 activity for a site. There may be a gain shift in the detector which will shift peaks to the right or left, or there may be a geometry change which changes efficiency, such as a cracked crystal. Both of these may be indicated by changes in the transmitted K-40 levels at a site. For those few sites where there is not enough natural K-40 present for this consistency check, a small amount of a commercial brand salt substitute, containing natural K-40, can be placed at a fixed distance from the detector so that the K-40 ROI can be monitored over time. Initially, it is NAREL's intent to use the mean K-40 activity for a site ± 3 standard deviations as trigger levels for investigation. With experience, these trigger levels may be adjusted.

As part of the DQO process, it was concluded that the null hypothesis for the automated check for near-real-time data coming into NAREL is that there is no activity present above normal background radiation at that site during the immediately preceding interval for ROIs other than K-40 and Be-7. Thus, the automated check will also trigger an alarm if the net activity exceeds a critical value based on the background measurements and radon daughter measurements. The final calculations will be made once the prototype of the fixed monitor is in place.

6.7.1.6 Beta Activity

Beta activity will be transmitted in five channels. Initially it is assumed that, except for radon and progeny, chiefly Pb-214 and Bi-214, both beta and gamma emitters, no activity should normally be detected above background in any beta channel. Over time, NAREL will trend background for the beta activity, calculate a critical value, and use this value to determine a trigger level for automatic checking.

6.7.1.7 Exposure Rate from Deployable Monitors

The deployable monitors will transmit exposure data, in μR/hour from two separate detectors and an average of the two. It is assumed that a current ambient exposure reading will be taken when each deployable unit is put into place and reported to NAREL data reviewers. Trigger levels will be set on a site and event-specific basis.

6.7.2 Verification and Review of Transmitted Near-Real Time Data

Transmitted data will first be checked by programmed automatic systems which will trigger alarms for investigation based on QA limits discussed in Section 3.6.1 of this document. During routine operations when an alarm is triggered, or during emergency operations for every transmission from an affected site, trained reviewers will scrutinize the data more fully. If, at any time, there is activity detected above the trigger level, (critical value), the data reviewer will pull up the complete spectrum, perform a peak search, and make semi-quantitative measurement of the activity present. If there is either an unexpected nuclide present or any single nuclide above the trigger level, a second independent reviewer will look at the data. Specific ROIs will be examined and, if time permits, the next hourly transmission from the same monitor will be scrutinized. If the reviewers determine that there is increased activity, the Laboratory Director will be notified and further actions will be determined.

6.8 Alerts, Corrective Action, and Decision-Making

If any data indicate a possible problem with instrumentation or the possibility of activity present, a corrective action process will be initiated as required by the NAREL SOP for Corrective Action. All steps in the investigation and resolution will be documented.

Investigation may include checking with the site operator, re-calibration or re-setting of instrument parameters, or reporting gamma or beta activity to the Laboratory director. At that point, actions will be event specific. As NAREL gains experience with the monitors over time, more specific decision steps may be developed for various possible situations.

When the presence of gamma or beta activity is verified, the Laboratory Director has the responsibility of notifying appropriate people and determining next steps.

6.9 Inclusion of Quality Assurance Data in ERD

In the expanded RadNet, QA data will be reported along with monitoring data. Historically, no quality assurance and monitoring information about the laboratory's work has been included in the quarterly Environmental Radiation Data (ERD) reports, an omission which makes it impossible for users to critically judge the quality of the data presented. Specific changes to the reporting program will alleviate this problem. A QA section will be included in each ERD and will include data, analysis, and interpretation of results of blanks, spiked samples, laboratory control samples, and performance evaluation samples associated with RadNet samples, allowing an independent review of the validity of RadNet data.

6.10 Field Audits and Periodic Evaluation of RadNet

It is vital to the continuous improvement of RadNet that formal evaluations be performed regularly, with emphasis on updating equipment and methods, maintaining levels of sample collection efficiency, and evaluating use and dissemination of the data. At NAREL, such an evaluation will become part of the mandated annual internal audit. The QA Manager annually assesses each part of the laboratory against NAREL's QA/QC policies, EPA requirements, and good laboratory practices. A broader, RadNet-wide evaluation should be conducted every three years. In order to maintain the interest and expertise required for a thorough and useful evaluation, NAREL will create and maintain a RadNet Review Committee comprised of staff actively involved in the day-to-day routine of RadNet sampling and analysis and supplemented during the review cycle by the QA manager and ORIA staff who do not work routinely with RadNet. The evaluation will require the team to review RadNet documentation including the QAPP, sampling and field procedures and equipment, sample tracking, analytical procedures and equipment, and QC data associated with RadNet since the previous review. On a broader scale, the Review Committee will look at the interest of the current users of the data to determine how well RadNet data are meeting the needs of the public and the scientific community. The review may include an evaluation of media sampled, sampling locations and frequencies, and the overall data quality objectives for the system.

6.11 Training, Testing, and Preparedness Exercises for Emergency Readiness

Because the sampling network must be prepared for rapid response in the event of an incident, it is critical that EPA personnel can inform the operators quickly, completely, and efficiently that an incident has occurred, and to provide details of what and how additional samples must be collected. It is also necessary that sample collectors and EPA staff have equipment in good working order and calibrated, and that sample collectors have sufficient sample containers and shipping materials to meet their immediate needs. NAREL must be able to get additional supplies to the samplers quickly. It is proposed that training for emergency activation be done using a combination of e-mail and regular mailings, an additional training video, and phone and fax communications in order to enable more rapid and efficient mobilization when an incident occurs.

An emergency readiness drill will improve the emergency response capability of the sampling networks. At least every two years, a mock incident will be developed. NAREL staff, presented with the incident information, will be required to evaluate the possible scope of the incident and determine what type of emergency samples are needed and from which locations in the network. Staff will then notify all appropriate station operators in the field of the incident and provide them with the needed numbers, types, locations, and frequencies of sampling, and any special shipping instructions. NAREL staff will monitor the time required to locate and inform operators and their response time during the readiness drill. They will review the response and present a report of findings and suggestions to the laboratory director and other appropriate personnel. A report of the results of the drill will also be sent to the sample collectors as part of their continual training, information, and evaluation. At regular intervals, an emergency readiness drill will be created which will include physical transport and setting up of at least some of the deployable air monitors.

In the final analysis, the ultimate goal of the RadNet QA and QC program is the continuous monitoring and improvement of all steps in the process, thus ensuring data that are accurate, reproducible, defensible, readily available, and useful to the public and the scientific community.

7 IMPLEMENTATION

7.1 Timelines

Interim expansion of the fixed-station air monitoring network using equipment on hand has been completed. In 2001, there were 52 ERAMS air monitoring stations in cities with about 27% of the U.S. population. New stations have been installed in eight major population centers: Dallas, Atlanta, Detroit, Philadelphia, Boston, Kansas City, San Francisco, and Washington. About 39% of the U.S. population resides in the population centers currently monitored.

An initial order for 52 fixed monitoring stations was placed in February 2005. They are to be installed at the rate of five units per month, beginning in 2006 and proceeding as locations are readied for a monitor, based on population as a priority. The order of placement will be re-evaluated when EPA receives the Science Advisory Board’s recommendations. With continued funding at current levels, deployment is expected to continue until approximately 130 monitors have been placed in service (estimated by the end of September 2007), after which the pace will be slower. Current plans are to have 180 fixed monitors operating by the end of Fiscal Year 2012.

7.2 Outreach

In the aftermath of a radiological emergency, there will be a critical need for sound, technical data upon which to base public-protection actions. Emergency responders and public officials already familiar with the monitoring system will be able to provide timely, accurate, and consistent information more quickly and effectively to help promote public protection and understanding. Lessons learned during emergency exercises have shown that a lack of communication among responders about technical data can ultimately lead to conflicting and inaccurate information being conveyed to the public, resulting in public confusion and distrust.

Outreach can help to defuse this lack of communication during an emergency by educating emergency responders and public officials about RadNet’s capabilities before an emergency occurs.

7.2.1 Audiences

To increase awareness of the monitoring system and its role, ORIA plans an outreach program to enhance the visibility of the monitoring system with key audiences. Of critical importance is the audience that will be implementing emergency procedures and/or communicating with the public or advising those who will. These include state and local radiation protection officials, such as Conference of Radiation Control Program Directors (CRCPD) members; state and local emergency response and management officials; local police and fire departments; and state and local health officials.

Other important audiences are state and local elected and appointed officials, such as mayors and governors, state and federal legislators, and the media. ORIA will also be building partnerships with a variety of organizations, including the National Response Team, the Interagency Modeling and Atmospheric Assessment Center, and other federal agencies involved in responding to a national emergency. (See Appendix J for more detail on outreach audiences.)

Another important audience is potential station operators. Since its inception in the 1950's, the monitoring system has been operated by volunteer operators, often state radiation protection officials. However, due to the increased number of monitoring stations, new operators will need to be recruited. Outreach will help to set the stage for recruitment efforts.

7.2.2 Strategic Approach

The strategic approach to outreach includes the following:

- Rename the system (from ERAMS to RadNet) to reflect its role and develop a compelling set of messages and communications tools for building an identity and awareness for the monitoring system with both internal and external audiences.
- Capitalize on scheduled opportunities where emergency responders gather and on existing relationships to gain attention for the RadNet.
- Use the CRCPD task force as a gateway to enhancing visibility within their organizations, agencies, and states.
- Build upon existing relationships with CRCPD to increase awareness of the monitoring systems capabilities.
- Increase visibility for the monitoring system through attention-getting activities associated with the siting of air stations.

7.2.3 Outreach Messages

Messages will be developed in conjunction with the monitoring project team and reflect the mission. Once developed, they will be used throughout the informational materials and in all public statements.

The following messages are recommended as a starting point:

- The monitoring system monitors radiation levels in the air, precipitation, drinking water, and pasteurized milk.
- In the event of a radiological emergency, the enhanced air portion of the monitoring system will provide timely, accurate, and consistent information on radiation levels associated with an emergency.
- Providing sound technical data during an emergency will help promote public protection and understanding.

7.2.4 Implementation

One of the first steps in implementing outreach was the selection of a new name for ERAMS with several considerations: the name needed to be descriptive of the system's capabilities and capture the system's value, free of copyright and trademark issues and acceptable to both the scientific and lay communities.

The new name was selected using a collaborative process. First, a series of staff brainstorms were held to develop a list of potential names and taglines. ORIA then received contractor counsel on the list of names, taglines and designs as well as copyright/trademark issues and received approval from the Office of Public Affairs on the concept. The team reviewed and discussed the list of potential names, taglines and designs, narrowing the selection to three. Elizabeth Cotsworth, ORIA's director, made the final decision on renaming the ERAMS program RadNet.

The focus of outreach then changed to developing a poster and an information package for the CRCPD April annual meeting launch of the new name. Included in the information package are one-page facts sheets featuring an overview of RadNet; EPA's role in responding to radiation emergencies; the new fixed air monitors; the new deployables; operator responsibilities and installation considerations.

The RadNet booth at the CRCPD meeting had two experts available to answer questions about RadNet, an eye-catching poster, and a deployable monitor on display. Information packets were handed out to all who visited the booth. To draw further attention to Radnet, there was a well-attended presentation on RadNet during the meeting.

Following the launch, ORIA has continued to take advantage of opportunities for raising the visibility of the monitoring system through speaking engagements and exhibiting. A deployable was displayed at a Superfund meeting in April and RadNet presentations were made at the National Reps meeting and the Local Emergency Planning Committees' meeting. Other potential speaking venues are being considered. A PowerPoint template with the RadNet logo has been developed for use in presentations.

ORIA has also sent thank you letters and certificates of appreciation to station operators, and letters of appreciation to their supervisors. Included in the mailing to both the operators and their supervisors is the information packet. This action will help to set the stage for retaining the current operators and recruiting new ones.

ORIA has tentative plans to host a publicity event inaugurating the placement and operation of one of the new air monitors and will consider holding local "ribbon-cutting ceremonies" for the placement of air monitors. A field exercise to test the deployable monitors will also offer an opportunity to increase awareness of RadNet's deployable capabilities.

In addition, ORIA plans to distribute information kits through mass mailings to key organizations, such as the National Governors Association and the U.S. Conference of Mayors in 2006. (See Appendix K for a full list of organizations targeted for outreach.)

Other outreach program components that ORIA is considering include holding workshops for technical staff on how to convey radiological information to non-technical communicators, for first and secondary communicators on what to expect during radiological emergencies, and for the media workshops on how to report on radiological emergencies.

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